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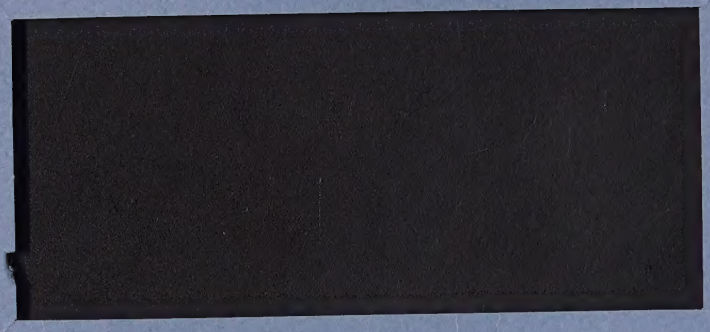

APPLICATION		REVISIONS			
USED ON	NEXT ASSY	LTR	DESCRIPTION	DATE	APPROVED

OPERATING AND MAINTENANCE HANDBOOK FOR KELTEC ONE-HALF RACK MOUNT 10 AND 20 WATT TWT AMPLIFIERS

CR — 620 SERIES — 20

OUT VARIES APPROX 2 DB

REV																												
SHEET	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
REV																												
SHEET	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
REV																												
SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES — TOL:
FRAC ± DEC ± ANG ±

MATERIAL

FINISH

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KELTEC FLORIDA
FORT WALTON BEACH, FLORIDA

OPERATING AND MAINTENANCE HANDBOOK
FOR KELTEC ONE-HALF RACK MOUNT
10 AND 20 WATT TWT AMPLIFIERS
620 SERIES

SIZE	CODE IDENT NO	
A	09062	74A0148

SCALE | SHEET 1 of 46 | REV

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1.0 GENERAL

1.1 APPLICATION

KELTEC 10 AND 20 WATT AMPLIFIERS TO WHICH THIS HANDBOOK APPLIES.

	10W AMPLIFIER PART NUMBER	20W AMPLIFIER PART NUMBER
LR620	74D0344	74D0351
SR620	74D0345	74D0352
SCR620	74D0346	- - -
CR620	74D0347	74D0353
CXR620	74D0348	74D0354
XR620	74D0349	74D0355
KUR620	74D0350	74D0356
XR621	- - -	74D0357
CR621	- - -	74D0277
SR620	74D0278	- - -
CR620	74D0279	- - -
SR620	74D0278	- - -
XR620	74D0280	- - -
CXR620	74D0276	- - -
CR620	74D0359	- - -
LR620	74D0360	- - -
SR620	74D0361	- - -
XR620	74D0362	- - -

1.2 SCOPE

THIS HANDBOOK IS DESIGNED TO MEET THE REQUIREMENTS OF THOSE PERSONNEL HAVING A RESPONSIBILITY TO INSTALL, OPERATE OR MAINTAIN THE KELTEC 10 AND 20 WATT 620 SERIES AMPLIFIERS.

SUFFICIENT DATA IS PROVIDED TO ENABLE TECHNICIANS TO DIAGNOSE AND REPAIR ANY FAULT WITHIN THE POWER SUPPLY EXCEPT THE HIGH VOLTAGE SECTION. IF THIS SECTION REQUIRES MAINTENANCE, THE ENTIRE AMPLIFIER SHOULD BE RETURNED TO THE FACTORY FOR SERVICING.

1.3 DESCRIPTION

THE 620 SERIES AMPLIFIERS ARE DESIGNED FOR LABORATORY APPLICATIONS, DATA LINK TRANSMISSIONS, AND GROUND BASED COMMUNICATIONS SYSTEMS. THE UNIT CAN BE MOUNTED IN ONE HALF OF A STANDARD 19-INCH DRAWER WITH BOTH THE RF INPUT AND OUTPUT JACKS ACCESSIBLE FROM THE REAR PANEL. THE UNIT IS ALSO AVAILABLE AS A COMPLETE ASSEMBLY FOR BENCH USE.

ALL OUTPUT VOLTAGES ARE REGULATED AND ALL ARE VARIABLE EXCEPT THE FILAMENT VOLTAGE WHICH IS FACTORY SET AS 6.3VDC. THE TRAVELING WAVE TUBE IS COOLED BY HEAT CONDUCTION TO ITS MOUNTING BASEPLATE AND WITH AN INTERNAL FAN.

1.4 FEATURES

THE FOLLOWING FEATURES CHARACTERIZE THE STANDARD MODELS OF THE KELTEC 620 SERIES AMPLIFIERS:

A. ONE-HALF RACK CONFIGURATION. REFER TO OUTLINE DRAWING FOR DIMENSIONS.

B. RF CONNECTORS MOUNTED ON REAR PANEL.

C. ON-OFF CIRCUIT BREAKER ON FRONT PANEL.

D. STANDBY-OPERATE SWITCH ON FRONT PANEL.

E. AMPLIFIER STATUS INDICATORS (POWER ON AND HIGH VOLTAGE ON).

F. TRAVELING WAVE TUBE PROTECTION; POWER SEQUENCING AND OVERLOAD.

G. COMPLETELY SOLID STATE POWER SUPPLY.

H. PROTECTION AGAINST LINE NOISE AND ARCING.

I. INPUT VOLTAGE AND FREQUENCY 115V $\pm$10% 48-63Hz.

J. ENVIRONMENTAL IN ACCORDANCE WITH MIL-T-21200, CLASS III.

K. TYPE "N" RF CONNECTORS FOR BOTH INPUT AND OUTPUT THROUGH X BAND. TYPE "SMA" RF CONNECTORS ON KU BAND.

L. EMI LINE FILTERS INTERNAL TO POWER SUPPLY.

M. LOW NOISE AND RIPPLE ON HIGH VOLTAGE SUPPLY OUTPUTS.

N. INTERNAL COOLING FAN.

O. EASILY REPAIRABLE POWER SUPPLY.

P. NO PERIODIC TUNING OR MAINTENANCE REQUIRED.

1.5 AVAILABLE OPTIONS

THE FOLLOWING OPTIONS ARE AVAILABLE PER CUSTOMER SPECIFICATION ON ANY MODEL OF THE 10 AND 20 WATT 620 AMPLIFIER SERIES.

A. RACK ADAPTER TO PROVIDE FOR MOUNTING TWO UNITS IN A STANDARD 19-INCH CABINET.

B. SPECIAL PAINTING OF UNIT.

C. LOW PASS FILTER (8GHz FUNDAMENTAL ONLY).

D. RF CONNECTORS MOUNTED ON FRONT PANEL.

E. 400Hz, 28VDC OR 48VDC INPUT OPERATION.

F. 230 VOLT OPERATION AT 50, 60 OR 400Hz.

G. HELIX CURRENT METER.

H. REMOTE OPERATION AND MONITORING.

I. TWT THERMAL OVERLOAD PROTECTION.

J. ALTERNATE OUTPUT CONNECTOR CONFIGURATIONS (TNC, WAVEGUIDE, ETC.).

2.0 SPECIFICATIONS

2.1 ELECTRICAL SPECIFICATIONS

PRIMARY INPUT VOLTAGE 115V ±10%

SINGLE PHASE, 60Hz

APPROXIMATE POWER CONSUMPTION

10 WATT UNITS 450 WATTS
20 WATT UNITS 500 WATTS

RF IMPEDANCE

INPUT 50 OHMS
OUTPUT 50 OHMS

2.2 MECHANICAL SPECIFICATIONS

WEIGHT - 10 WATT UNITS, 22 POUNDS MAXIMUM
20 WATT UNITS, 25 POUNDS MAXIMUM

OPERATING ENVIRONMENT SEA LEVEL TO 10,000 FEET.

FINISH
FRONT PANEL: BEIGE WITH BLACK TRIM.

TYPE OF CONNECTORS

PRIMARY POWER INPUT: STANDARD 8 ft., 3 CONDUCTOR FLEXIBLE CORD WITH GROUND PIN

RF INPUT AND OUTPUT: TYPE "N" THROUGH X BAND; TYPE "SMA" FOR KU BAND.

OPERATING POSITION: ANY

3.0 OPERATING INSTRUCTIONS

3.1 INSTALLATION

THE 620 SERIES AMPLIFIERS REQUIRE NO PARTICULAR INSTALLATION BEYOND ASSURING THAT AIR FLOW TO THE FRONT AND REAR PANELS IS NOT RESTRICTED.

IF A RACK ADAPTER IS USED TO MOUNT THE AMPLIFIER IN A STANDARD 19-INCH RACK, THE RACK ADAPTER SHOULD BE MOUNTED SECURELY INTO THE CABINET BEFORE THE AMPLIFIER IS INSTALLED INTO THE ADAPTER. AFTER THIS IS DONE, THE AMPLIFIER WILL SLIDE SMOOTHLY ALONG THE ADAPTER GUIDE RAILS. THE AMPLIFIER SHOULD THEN BE SECURED WITHIN THE ADAPTER BY ATTACHING THE AMPLIFIER RETAINING BAR TO THE ADAPTER.

3.2 FRONT PANEL CONTROLS AND INDICATORS

TWO CONTROLS AND TWO INDICATORS ARE MOUNTED ON THE FRONT PANEL. THE 7.5 AMPERE PRIMARY POWER CIRCUIT BREAKER APPLIES POWER TO THE AMPLIFIER AND AS IT DOES SO, THE WHITE, POWER ON INDICATOR LAMP WILL LIGHT.

HIGH VOLTAGE CAN BE APPLIED TO THE TRAVELING WAVE TUBE, AFTER THE INITIAL 90-SECOND TIME DELAY PERIOD, BY MOVING THE STANDBY-OPERATE TOGGLE SWITCH TO THE OPERATE POSITION. SIMULTANEOUSLY, THE GREEN OPERATE INDICATOR LAMP WILL LIGHT.

3.3 OPERATING PROCEDURE

3.3.1 FIRST TIME OPERATION

BEFORE THE AMPLIFIER IS TURNED ON, IT IS WELL TO CHECK ALL ACCESSIBLE CONNECTORS TO BE CERTAIN THEY HAVE NOT WORKED LOOSE DURING SHIPPING. BEFORE CONNECTING THE PRIMARY POWER, BE CERTAIN THAT IT MATCHES THE AMPLIFIER INPUT REQUIREMENTS.

3.3.2 NORMAL OPERATION

TURN OFF THE MAIN CIRCUIT BREAKER AND PLACE THE STANDBY-OPERATE SWITCH IN STANDBY. CONNECT THE RF INPUT AND OUTPUT PORTS TO THEIR RESPECTIVE SOURCE AND LOAD. PLUG THE POWER CORD INTO A SUITABLE SOURCE OF POWER. CLOSE THE MAIN CIRCUIT BREAKER. THE WHITE POWER LAMP SHOULD LIGHT. AFTER THE ELAPSE OF APPROXIMATELY 90 SECONDS, MOVE THE STANDBY-OPERATE SWITCH TO THE OPERATE POSITION. SIMULTANEOUSLY, THE GREEN POWER INDICATOR LAMP WILL LIGHT. THE AMPLIFIER IS NOW IN FULL OPERATION.

4.0 BLOCK DIAGRAM DISCUSSION

THE BASIC ELECTRICAL FUNCTIONS OF THE POWER SUPPLY COMPONENTS FOR THE 10 AND 20 WATT AMPLIFIERS ARE SHOWN INTERCONNECTED IN BLOCK DIAGRAM FORM IN FIGURE 1. PRIMARY POWER ENTERS THROUGH A 7.5A CIRCUIT BREAKER INTO AN AUTOTRANSFORMER IF THE AMPLIFIER IS DESIGNED TO OPERATE FROM THE 220 VOLT LINE. THE PURPOSE OF THE AUTOTRANSFORMER IS TO LOWER THE INPUT VOLTAGE TO THE REQUIRED LEVEL. IF THE AMPLIFIER IS DESIGNED TO OPERATE FROM THE 115 VOLT LINE, THE AUTOTRANSFORMER IS OMITTED. THE POWER SUPPLY RECEIVES POWER FROM THE POWER MAINS AND CONVERTS IT INTO DC VOLTAGE FOR OPERATING THE TRAVELING WAVE TUBE. FIVE CONNECTIONS TO THE TRAVELING WAVE TUBE ARE SHOWN AS OUTPUTS OF THE POWER SUPPLY.

ALL POWER TO THE SUPPLY IS PASSED THROUGH AN ELECTRO-MAGNETIC INTERFERENCE (EMI) FILTER. THE PRIMARY FUNCTION OF THE FILTER IS TO ATTENUATE TRANSIENTS GENERATED BY THE POWER SUPPLY BEFORE THEY APPEAR ON THE POWER MAINS.

THE FILTERED AC INPUT POWER IS RECTIFIED AND FILTERED BY A BRIDGE RECTIFIER AND CAPACITIVE FILTER. IT THEN BRANCHES TO TWO SERIES REGULATORS. ONE SERIES REGULATOR

4.0 (CONTINUED)

THE DC TO DC CONVERTER OPERATES FROM THE OUTPUT OF THE OTHER SERIES REGULATOR. THE CONTROL CIRCUIT DETERMINES WHETHER IT OPERATES OR NOT. THE DC TO DC CONVERTER GENERATES CATHODE AND COLLECTOR VOLTAGES FOR THE TRAVELING WAVE TUBE. THERE ARE TWO BRIDGE RECTIFIER-FILTER CIRCUITS CONNECTED IN SERIES IN ITS OUTPUT. THE CATHODE IS CONNECTED TO THE HIGHEST NEGATIVE VOLTAGE AND THE COLLECTOR IS CONNECTED TO THE MID-POINT OF THE TWO CIRCUITS. THE HELIX IS CONNECTED TO GROUND WHICH IS THE MOST POSITIVE OUTPUT VOLTAGE. THEREFORE, THE COLLECTOR IS MORE NEGATIVE (DEPRESSED) THAN THE HELIX.

HELIX CURRENT IS SENSED BY THE HELIX OVERLOAD CIRCUIT. IF THE HELIX CURRENT EXCEEDS A PREDETERMINED MAXIMUM VALUE, THE OVERLOAD CIRCUIT SIGNALS THE CONTROL CIRCUIT TO SHUTDOWN THE DC TO DC CONVERTER WHICH SUPPLIES THE HIGH VOLTAGE. RESET IS ACCOMPLISHED BY SWITCHING THE AMPLIFIER TO STANDBY AND THEN BACK TO OPERATE, EITHER WITH THE FRONT PANEL CONTROL OR REMOTELY.

4.0 (CONCLUDED)

THE 90-SECOND TIMER AND CONTROL CIRCUIT INHIBIT HIGH VOLTAGE GENERATION UNTIL THE HEATER HAS BEEN ON 90 SECONDS. (APPLYING HIGH VOLTAGE TO A TRAVELING WAVE TUBE WITH A COLD FILAMENT SHORTENS ITS LIFE.)

THE CONTROL CIRCUIT ALSO OPERATES THE HIGH VOLTAGE ON AND POWER ON INDICATIONS.

5.0 POWER SUPPLY CALIBRATION

5.1 INTRODUCTION

WHENEVER THE TRAVELING WAVE TUBE IS REPLACED, SOME CHANGES MUST USUALLY BE MADE IN THE OPERATING VOLTAGES TO THE TUBE.

IT IS RECOMMENDED THAT PRIOR TO CONNECTING THE NEW TRAVELING WAVE TUBE TO THE POWER SUPPLY, A RESISTIVE DUMMY LOAD BE USED WHILE ADJUSTING THE POWER SUPPLY OUTPUTS TO MATCH THE REQUIREMENTS OF THE NEW TUBE. FIGURE 3 SHOWS THE WIRING CONNECTIONS FOR SUCH A LOAD.

THE EXACT RESISTANCE VALUES SELECTED FOR EACH LOAD WILL DEPEND UPON THE VOLTAGE AND CURRENT REQUIREMENTS OF THE PARTICULAR TUBE BEING INSTALLED. THIS INFORMATION IS STAMPED ON EACH TRAVELING WAVE TUBE OR CAN BE OBTAINED FROM THE TUBE MANUFACTURER'S LITERATURE. THE FORMULAS REQUIRED TO COMPUTE THE LOAD RESISTOR VALUES FROM THE MANUFACTURER'S DATA ARE GIVEN. THE WATTAGE OF THE RESISTORS USED SHOULD BE AT LEAST THE NEXT HIGHER STANDARD WATTAGE VALUE AVAILABLE FROM THAT COMPUTED BY THE FORMULAS.

5.1.1 LOAD RESISTOR COMPUTATIONS

THE FOLLOWING FORMULAS CAN BE USED TO DETERMINE THE RESISTANCE VALUE TO PLACE IN THE TEST LOAD. THE INFORMATION REQUIRED WILL BE FOUND EITHER STAMPED ON THE TRAVELING WAVE TUBE OR IN THE TUBE MANUFACTURER'S LITERATURE.

---FOR THE HEATER RESISTOR USE:

$$R\ (\text{OHMS}) = \frac{\text{FILAMENT VOLTAGE (VOLTS)}}{\text{FILAMENT CURRENT (AMPERES)}}$$

$$R_f = \frac{V_f}{I_f}$$

$$P\ (\text{WATTS}) = V_f \times I_f$$

---FOR HELIX RESISTOR USE:

$$R\ (\text{OHMS}) = \frac{\text{HELIX (OR CATHODE) VOLTAGE (VOLTS)}}{\text{HELIX CURRENT (AMPERES)}}$$

$$R_H = \frac{V_K}{I_H}$$

$$P\ (\text{WATTS}) = V_K \times I_H$$

(THE RESISTORS USED MUST BE CAPABLE OF WITHSTANDING THE HIGH VOLTAGE.)

---FOR THE COLLECTOR RESISTOR USE:

$$R\ (\text{OHMS}) = \frac{\text{COLLECTOR VOLTAGE (VOLTS)}}{\text{CATHODE CURRENT - HELIX CURRENT (AMPERES)}}$$

$$R_C = \frac{V_C}{I_K - I_H} \qquad P\ (\text{WATTS}) = V_C \times (I_K - I_H)$$

(THE RESISTORS USED MUST BE CAPABLE OF WITHSTANDING HIGH VOLTAGE.)

5.2 TEST EQUIPMENT AND TOOLS REQUIRED

THE FOLLOWING ITEMS ARE REQUIRED FOR FIELD CALIBRATION OF THE 620 SERIES POWER SUPPLIES.

ONE DC VOLTMETER CAPABLE OF MEASURING BETWEEN 6 AND 5,000 VOLTS, SUCH AS A TRIPLETT MODEL 630.

THREE HIGH WATTAGE, HIGH VOLTAGE, RESISTORS.

ONE INSULATED SCREW DRIVER.

5.3 VOLTAGE ADJUSTMENT PROCEDURE

5.3.1 DISCONNECT ALL INPUT POWER TO THE POWER SUPPLY.

5.3.2 CONNECT THE DUMMY LOAD RESISTORS TO THE POWER SUPPLY. REFER TO FIGURE 3.

5.3.3 BE CERTAIN THE STANDBY-OPERATE SWITCH IS IN STANDBY.

5.3.4 CONNECT THE PRIMARY INPUT POWER.

5.3.5 TURN ON THE MAIN CIRCUIT BREAKER.

5.3.6 ADJUST THE INPUT VOLTAGE TO 115VRMS.

5.3.7 MEASURE THE VOLTAGE ACROSS THE HEATER RESISTOR. IT SHOULD BE 6.3 VOLTS DC. THE FILAMENT VOLTAGE IS NOT ADJUSTABLE.

5.3.8 TURN OFF THE MAIN CIRCUIT BREAKER.

5.3.9 THE FIRST OF THE TWO ADJUSTMENTS IS THE HELIX VOLTAGE (OR CATHODE VOLTAGE AS IT IS SOMETIMES CALLED). THE HELIX VOLTAGE ADJUSTMENT IS R22. THIS ADJUSTMENT IS BY FAR THE MORE IMPORTANT AND MORE CRITICAL OF THE TWO ADJUSTMENTS. REFER TO FIGURE 4 FOR LOCATION OF THE ADJUSTMENT.

5.3.10 CONNECT A HIGH RANGE VOLTMETER ACROSS THE HELIX RESISTOR.

5.3.11 APPLY PRIMARY POWER AND WAIT FOR THE 90-SECOND DELAY PERIOD TO ELAPSE.

CAUTION: BE CAREFUL TO AVOID ELECTRICAL SHOCK.

5.3.12 SWITCH THE STANDBY-OPERATE SWITCH TO OPERATE. USE AN INSULATED SCREWDRIVER TO ADJUST R22 UNTIL THE PROPER VOLTAGE IS OBTAINED.

5.3.13 SWITCH BACK TO STANDBY AND OPEN THE MAIN CIRCUIT BREAKER.

5.3.14 REMOVE PRIMARY POWER INPUT.

5.3.15 THE VOLTAGE ACROSS THE ANODE TERMINAL SHOULD BE ADJUSTED NEXT. NOTE THAT SOME TRAVELING WAVE TUBES DO NOT HAVE AN ANODE ELEMENT IN WHICH CASE THIS PARAGRAPH DOES NOT APPLY. CONSULT THE TUBE MANUFACTURER'S DATA TO ASCERTAIN THE EXACT VALUE REQUIRED FOR THE TRAVELING WAVE TUBE ON HAND.

5.3.16 CONNECT A SUITABLE VOLTMETER BETWEEN THE ANODE TERMINAL AND PIN B OF CONNECTOR PM6H.

5.3.17 TURN ON THE MAIN CIRCUIT BREAKER AND WAIT FOR THE 90-SECOND DELAY PERIOD TO ELAPSE BEFORE TURNING ON THE HIGH VOLTAGE WITH THE STANDBY-OPERATE SWITCH.

5.3.18 ADJUST R34 WITH AN INSULATED SCREWDRIVER TO OBTAIN THE DESIRED ANODE VOLTAGE. SEE FIGURE 4 FOR THE LOCATION OF R34.

5.3.19 AFTER THE ANODE VOLTAGE ADJUSTMENT HAS BEEN COMPLETED, SWITCH TO STANDBY AND TURN OFF THE MAIN CIRCUIT BREAKER.

5.3.20 THE COLLECTOR VOLTAGE IS NOT CRITICAL AND IS ADJUSTABLE ONLY AS THE CATHODE OUTPUT VOLTAGE IS ADJUSTED. HOWEVER, A CHECK SHOULD BE MADE TO VERIFY ITS PRESENCE. PROCEED AS FOLLOWS.

5.3.21 REMOVE THE PRIMARY POWER. BE CERTAIN THE OPERATE-STANDBY SWITCH IS IN STANDBY.

5.3.22 CONNECT A VOLTMETER ACROSS THE COLLECTOR RESISTOR.

CAUTION: A HIGH VOLTAGE WILL EXIST ACROSS THE HELIX RESISTOR ANY TIME THE STANDBY SWITCH IS IN THE OPERATE POSITION. BE CAREFUL TO AVOID ELECTRICAL SHOCK.

5.3.23 CLOSE THE MAIN CIRCUIT BREAKER AND WAIT FOR THE 90-SECOND TIME DELAY PERIOD TO ELAPSE.

5.3.24 SWITCH THE STANDBY-OPERATE SWITCH TO OPERATE AND READ THE VOLTMETER.

5.2.25 SWITCH BACK TO STANDBY. OPEN THE MAIN CIRCUIT BREAKER.

5.3.26 THIS COMPLETES THE CALIBRATION OF THE POWER SUPPLY.

6.0 MAINTENANCE DATA

THIS SECTION HAS BEEN PREPARED TO AID IN TROUBLESHOOTING THE AMPLIFIER. THE TROUBLESHOOTING CHART (TABLE II) WILL BE USEFUL IN ISOLATING A FAULT TO THE TRAVELING WAVE TUBE OR POWER SUPPLY OR A COMBINATION OF THE TWO. THE TROUBLESHOOTING GUIDE LISTS SEVERAL SYMPTOMS OF TROUBLE AND WHICH COMPONENTS SHOULD BE CHECKED WHEN THESE SYMPTOMS APPEAR. VOLTAGE DATA IS INCLUDED WHICH WAS OBTAINED FROM A PROPERLY OPERATING UNIT. IN ADDITION, WAVEFORMS TAKEN AT KEY POINTS ARE SHOWN. THESE WAVEFORMS ARE REPRODUCTIONS OF UNRETOUCHED PHOTOGRAPHS.

6.1 TROUBLESHOOTING GUIDE

NOTE: DO NOT ATTEMPT TO REPAIR THE AMPLIFIER IF IT IS WITHIN THE WARRANTY PERIOD. RETURN IT TO THE FACTORY FOR REPAIR.

CAUTION: LETHAL VOLTAGES ARE PRESENT IN THIS EQUIPMENT WHEN IT IS OPERATING NORMALLY. WHEN IT IS MALFUNCTIONING, LETHAL VOLTAGES MAY BE PRESENT IN UNEXPECTED LOCATIONS. EXERCISE CAUTION WHEN SERVICING THIS EQUIPMENT.

6.1.1 AMPLIFIER MALFUNCTIONS

MALFUNCTIONS OF THE AMPLIFIER ARE MANIFESTED IN SEVERAL WAYS. SOME OF THESE ARE:

A. IMPROPER RF OUTPUT (OR NO RF OUTPUT).

B. REPEATED FAULT INDICATIONS.

C. NO RESPONSE TO CONTROLS.

D. EXCESSIVE INPUT CURRENT.

E. ARCING SOUNDS OR BURNT COMPONENT ODORS.

THE FIRST PRIORITY IN LOCATING A FAULT IS ISOLATING IT TO THE TRAVELING WAVE TUBE OR POWER SUPPLY. A TROUBLESHOOTING CHART IS PROVIDED AS TABLE II TO AID IN THIS PHASE OF THE DIAGNOSIS. IF THE FAULT CANNOT BE ISOLATED TO THE TRAVELING WAVE TUBE WITH THE CHART, THE NEXT STEP IS TO DISCONNECT THE TRAVELING WAVE TUBE AND FOLLOW THE CALIBRATION PROCEDURE GIVEN FOR THE POWER SUPPLY. IF THE POWER SUPPLY CALIBRATES PROPERLY AND THERE ARE NO OVERT SIGNS OF POWER SUPPLY MALFUNCTION, THE TRAVELING WAVE TUBE MAY BE ASSUMED FAULTY AND REPLACEMENT IS THE ONLY COURSE OF ACTION.

6.1.2 POSSIBLE CAUSES OF FAULTS

THE POSSIBLE CAUSES OF FAULTS ARE MANY AND NO ATTEMPT HAS BEEN MADE TO LIST ALL OF THEM. HOWEVER, THE INFORMATION GIVEN DOES LIST PROBABLE CAUSES AND THESE SHOULD BE CHECKED AFTER A VISUAL INSPECTION FAILS TO DISCLOSE THE SOURCE OF TROUBLE.

6.1.3 NO RF OUTPUT

A. CHECK THAT SUFFICIENT RF INPUT POWER IS APPLIED IN THE CORRECT FREQUENCY BAND.

B. CHECK THAT THE OPERATE LAMP (GREEN) IS LIGHTED.

C. CHECK THAT CORRECT LINE VOLTAGE IS APPLIED AND THAT THE CIRCUIT BREAKER IS CLOSED.

D. CHECK THAT THE HELIX CURRENT METER INDICATES SEVERAL MILLIAMPERES OF CURRENT. THE HELIX CURRENT METER IS AN OPTIONAL FEATURE AND MAY NOT APPEAR ON SOME AMPLIFIERS.

E. CHECK ALL RF CONNECTIONS.

F. IF ALL THE ABOVE CHECKS GIVE GOOD RESULTS, IT IS LIKELY THAT THE TRAVELING WAVE TUBE IS FAULTY. HOWEVER, TO BE SURE, THE POWER SUPPLY SHOULD BE CONNECTED TO THE DUMMY CALIBRATION LOAD AND CHECKED PER THE CALIBRATION PROCEDURE (SEE PARA 5.0).

G. POWER SUPPLY FAULTS THAT COULD RESULT IN NO RF OUTPUT ARE LOSS OF HIGH VOLTAGE, OVERLOAD, LOSS OF HEATER VOLTAGE, AND CONTROL CIRCUIT FAULTS. ALL OF THESE FAULTS CAN BE DETECTED WITH THE CALIBRATION PROCEDURE.

6.1.4 LOW RF OUTPUT

A. CHECK THAT SUFFICIENT RF DRIVE POWER IN THE PROPER FREQUENCY RANGE IS APPLIED.

B. CHECK ALL RF CONNECTIONS AND INPUT/OUTPUT VSWR (SHOULD BE $\leq$2.5:1).

C. POSSIBLE CAUSES OF LOW RF OUTPUT ARE LOW GAIN TWT, LOW CATHODE EMISSION IN THE TWT, LOW HEATER VOLTAGE, IMPROPER CATHODE VOLTAGE. THE POWER SUPPLY SHOULD BE CHECKED PER THE CALIBRATION PROCEDURE AS OUTLINED IN PARA 5.0. IF IT CHECKS SATISFACTORY ON ALL OUTPUTS, THE TRAVELING WAVE TUBE IS PROBABLY FAULTY.

6.1.5 POWER OUTPUT VARIES WITH LINE VOLTAGE

THIS IS CAUSED BY LOSS OF HELIX VOLTAGE REGULATION. THE FOLLOWING COMPONENTS IN THE POWER SUPPLY COULD CAUSE THIS CONDITION:

Q6, Q11 OR Q19 COULD BE SHORTED

CR28 NOT STABLE AT NINE VOLTS.

6.1.6 HIGH RF NOISE

TERMINATE THE TRAVELING WAVE TUBE INPUT WITH 50 OHMS. IF THE NOISE PERSISTS, THERE IS A FAULT IN THE TRAVELING WAVE TUBE, MOST LIKELY IT IS OSCILLATING. INCORRECT VOLTAGES FROM THE POWER SUPPLY COULD CONCEIVABLY CAUSE OSCILLATION SO THE POWER SUPPLY SHOULD BE CHECKED PER THE CALIBRATION PROCEDURE (OUTLINED IN PARA 5.0) BEFORE REPLACING THE TRAVELING WAVE TUBE.

6.1.7 4KHz MODULATION ON THE RF OUTPUT

A. THIS IS CAUSED BY EXCESSIVE RIPPLE ON THE CATHODE TO HELIX VOLTAGE. THIS CAN OCCUR IF THE HIGH VOLTAGE FILTER OPENS OR THE REGULATOR IS MALFUNCTIONING OR THE REGULATOR HAS REDUCED HIGH FREQUENCY GAIN.

B. CHECK C15, C16, C20, C21, C22 FOR OPEN CONDITION.

C. CHECK Q16, Q17 FOR LOW GAIN.

6.1.8 HELIX OVERCURRENT OVERLOADS REPEATEDLY

A. THIS CAN BE CAUSED BY ARC PATHS IN THE TRAVELING WAVE TUBE OR HIGH VOLTAGE SECTION OF THE POWER SUPPLY.

B. DISCONNECT THE TRAVELING WAVE TUBE AND CHECK FOR OVERLOADS. IF THE POWER SUPPLY DOES NOT OVERLOAD AT NO LOAD EITHER THE TRAVELING WAVE TUBE IS ARCING OR R28 IS TOO HIGH IN VALUE. CONNECT A DUMMY LOAD TO THE CATHODE OUTPUT AND SELECT R28 FOR THE MAXIMUM DESIRED HELIX CURRENT. RECONNECT THE TRAVELING WAVE TUBE.

C. OTHER POSSIBLE CAUSES OF THIS MALFUNCTION ARE: C22 SHORTED
C18 OPEN.

6.1.9 EXCESSIVE INPUT CURRENT

A. THIS IS ALMOST CERTAINLY CAUSED BY A SHORT IN ONE OF THE INPUT COMPONENTS OR WIRING. THE INPUT CIRCUIT BREAKER SHOULD OPEN.

B. MAKE AN OHMMETER CHECK OF THE FILAMENT BUS AND THE HELIX BUS.

C. CHECK THE FOLLOWING COMPONENTS FOR SHORTS: BLOWER MOTOR, C1 THROUGH C5, AND C17.

6.1.10 LOW FREQUENCY MODULATION OF THE RF OUTPUT. THIS IS AN INDICATION OF HELIX REGULATOR OSCILLATION. CHECK C5 FOR LOW CAPACITANCE IF OUTPUT VOLTAGE IS HIGH, ALSO CHECK FOR OPEN FEEDBACK LOOP IN HELIX REGULATOR.

6.2 VOLTAGE DATA

6.2.1 CONDITIONS OF MEASUREMENT

INPUT VOLTAGE	117	VAC	
CATHODE VOLTAGE	-3440	VDC	— 2100
HEATER VOLTAGE	6.3	VDC	
ANODE VOLTAGE	+275	VDC	WITH RESPECT TO CATHODE

ALL OUTPUTS WERE LOADED TO SIMULATE A TRAVELING WAVE TUBE IN NORMAL OPERATION.

A TRIPLETT MODEL 630 SERIES VOLT-OHM-MILLIAMMETER WAS USED TO TAKE THE VOLTAGE READINGS.

ALL VOLTAGES WERE RECORDED WITH RESPECT TO CIRCUIT GROUND EXCEPT THE THREE MARKED WITH AN ASTERISK. THESE THREE ARE RECORDED WITH RESPECT TO CHASSIS GROUND.

NOTE: THESE VOLTAGES TAKEN ON A PROPERLY OPERATING XR621-20 AMPLIFIER. VOLTAGES ARE TYPICAL AND ARE MEANT TO BE USED AS A GUIDE. VOLTAGES ON A DIFFERENT UNIT MAY BE SOMEWHAT DIFFERENT.

6.2.2 VOLTAGE READINGS

READING NUMBER	TAKEN AT	VOLTAGE MEASURED
1	POSITIVE TERMINAL OF C17	160.00VDC
2	POSITIVE TERMINAL OF C6	118.00VDC
3	CATHODE OF CR5, CR6 OR CR7	230.00VDC
4	COLLECTOR OF Q3	118.00VDC
5	EMITTER OF Q18	8.00VDC
6	COLLECTOR OF Q6	160.00VDC
7	POSITIVE TERMINAL OF C16	122.00VDC
8	BASE OF Q12	120.00VDC
9	CATHODE OF CR28	9.20VDC
10	CATHODE OF CR26 OR CR27	20.00VDC
11	EMITTER OF Q4 OR Q5	0.50VDC
12	EMITTER OF Q14 OR Q15	8.60VDC
*13	ANODE OF Q9	28.00VDC
*14	COLLECTOR OF Q10	0.90VDC
*15	ANODE OF Q7	17.00VDC

ALL VOLTAGES SHOWN ABOVE ARE POSITIVE.

6.3 WAVEFORM DATA

6.3.1 CONDITIONS OF MEASUREMENTS

6.3.2 WAVEFORMS

WAVEFORM 1 - 50MS/CM AT 2V/CM TAKEN AT THE BASE OF Q4.

WAVEFORM 2 - 50MS/CM AT 2V/CM TAKEN AT THE BASE OF Q5.

WAVEFORM 3 - 50MS/CM AT 50V/CM TAKEN AT THE COLLECTOR OF Q5.

WAVEFORM 4 - 50MS/CM AT 50V/CM TAKEN AT THE COLLECTOR OF Q4.

WAVEFORM 5 - 50MS/CM AT 2V/CM TAKEN AT THE JUNCTION OF R11 AND K1 CONTACT.

WAVEFORM 6 - 50MS/CM AT 2V/CM TAKEN AT THE JUNCTION OF R10 AND K1 CONTACT.

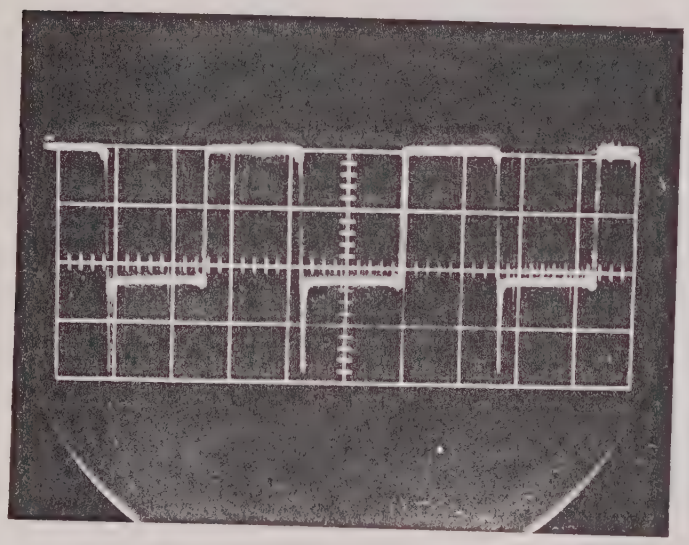
WAVEFORM 7 - 50MS/CM AT 50V/CM TAKEN AT THE COLLECTOR OF Q16.

WAVEFORM 8 - 50MS/CM AT 50V/CM TAKEN AT THE COLLECTOR OF Q17.

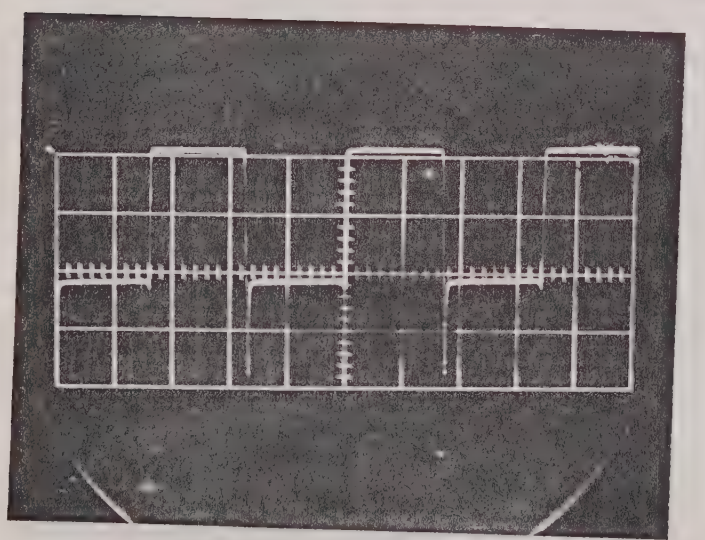
WAVEFORM 9 - 50MS/CM AT 2V/CM TAKEN AT THE BASE OF Q16.

WAVEFORM 10- 50MS/CM AT 2V/CM TAKEN AT THE BASE OF Q17.

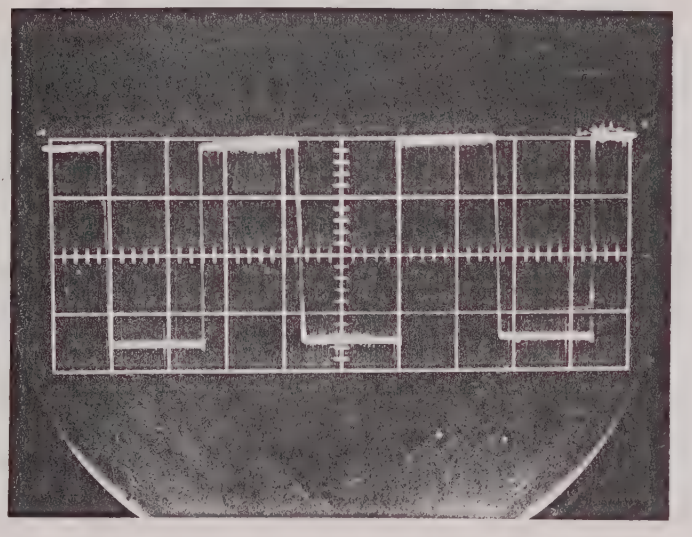
6.3.2 WAVEFORMS (CONTINUED)



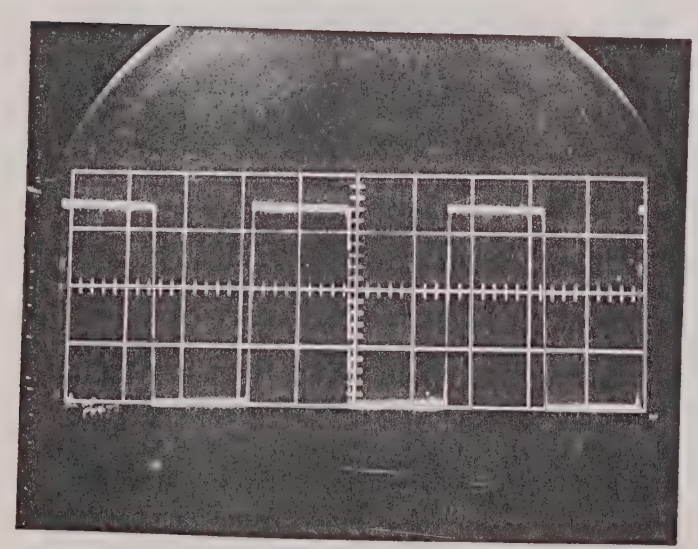
WAVEFORM 1



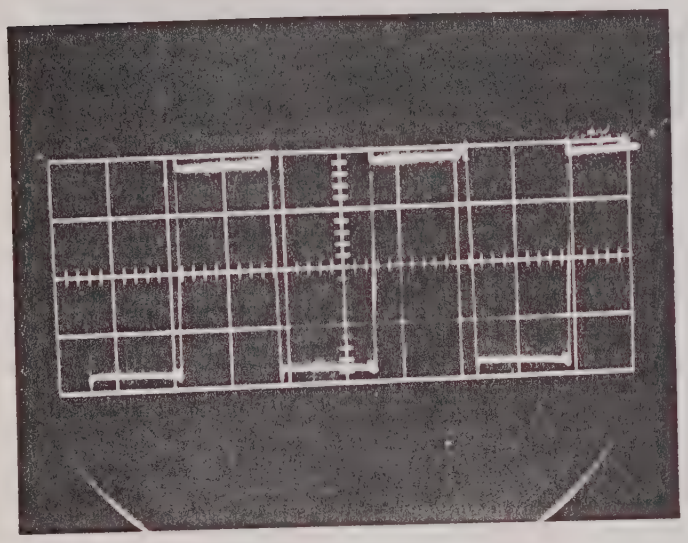
WAVEFORM 2



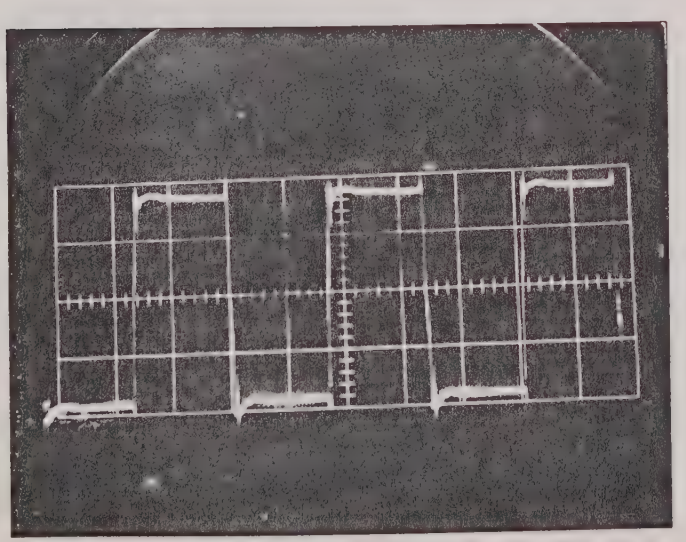
WAVEFORM 3



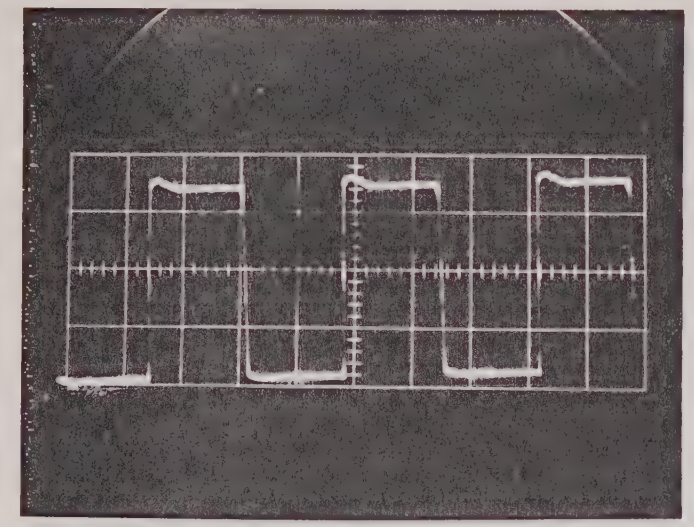
WAVEFORM 4



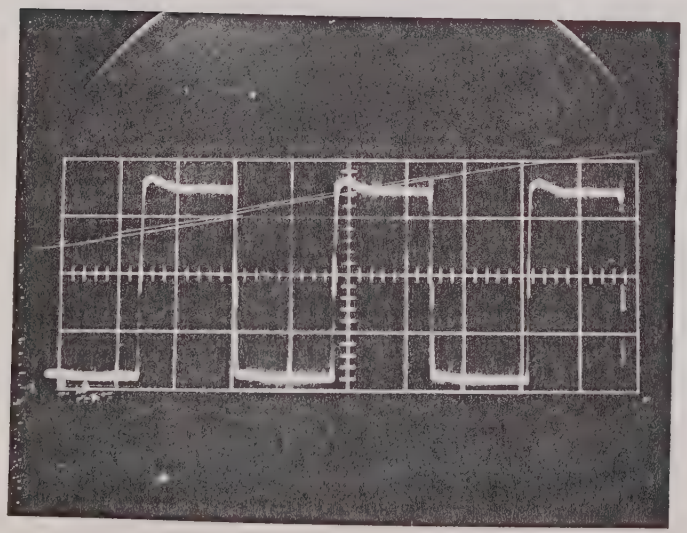
WAVEFORM 5



WAVEFORM 6

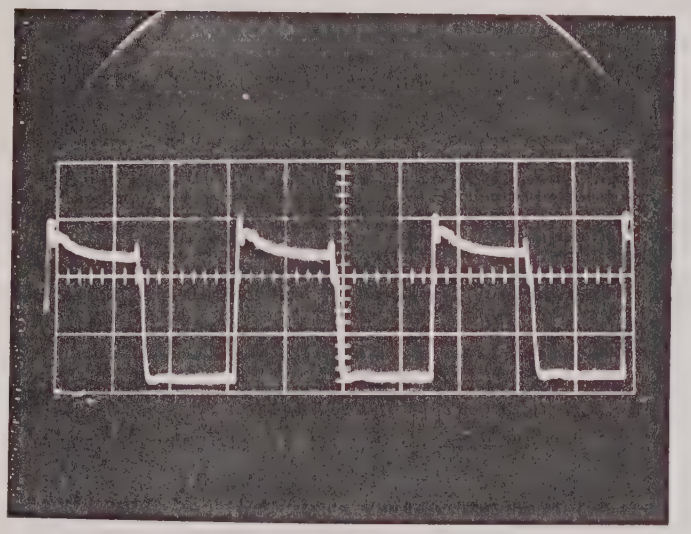


WAVEFORM 7

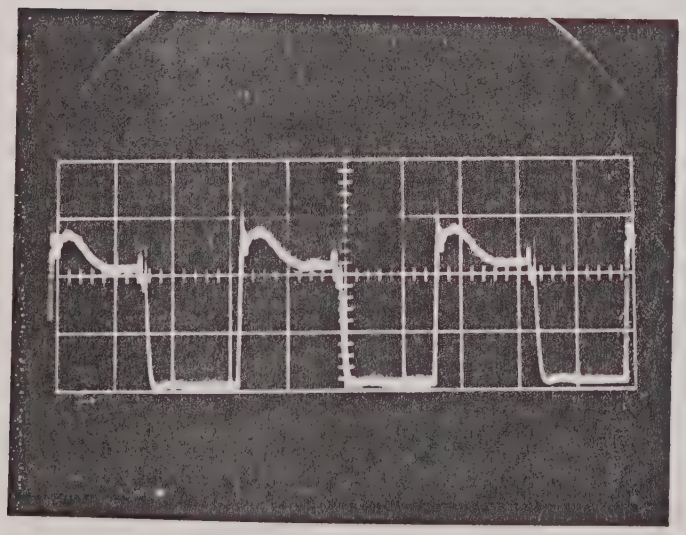


WAVEFORM 8

6.3.2 WAVEFORM (CONTINUED)



WAVEFORM 9



WAVEFORM 10

TABLE I - TWT ELECTRICAL DATA

R620 SERIES AMPLIFIER DATA

10 AND 20 WATT

MODEL	TUBE	HELIX VOLTAGE	COLL VOLTAGE	FILAMENT AMPERES AT 6.3V	TWT EQUIPPED WITH ANODE/GRID
LR620-10	L5036	1125-1375	GND	1.4	YES
SR620-10	VTS-6055-A1	1600-1900	1050	0.5	YES
SCR620-10	L5134	2600-2900	GND	1.2	YES
CR620-10	VTC-6069-A1	2600-2900	1900	0.5	YES
CXR620-10	L5043	2850-3100	GND	1.3	YES
XR620-10	VTX-6089-H3	3200-3600	2100	1.1	YES
KUR620-10	VTU-6091-A1	3800-4050	2500	1.2	NO
LR620-20	VTL-6140-B1	1400-1650	1300	1.6	NO
SR620-20	VTS-6150-B1	1600-1800	1400	0.95	NO
CR620-20	VTC-6160-B1	2300-2500	1500	0.95	NO
CXR620-20	VTH-6160-B1	3100-3300	1600	0.95	NO
XR620-20	VTX-6180-B1	3100-3300	1600	0.95	NO
KUR620-20	VTU-6191-A1	3750-4050	2500	1.4	NO
XR621-20	M5793B	3000-3400	1600		YES
SR620-10	VTS-6055-A1	1600-1900	1050	0.5	YES
LR620-10	L5036	1125-1375	GND	1.4	YES

TABLE II

TROUBLESHOOTING CHART

PARA	AMPLIFIER FAULT SYMPTOM	FAULTY UNIT		
		TWT	P.S.	EITHER TWT, P.S. OR BOTH
6.1.3	NO RF OUTPUT			✓
6.1.4	LOW RF OUTPUT			✓
6.1.5	POWER OUTPUT VARIES WITH LINE VOLTAGE		✓	
6.1.6	HIGH RF NOISE	✓		
6.1.7	4KHz MODULATION ON RF OUTPUT		✓	
6.1.8	HELIX OVERCURRENT OVERLOADS REPEATEDLY			✓
6.1.9	EXCESSIVE INPUT CURRENT		✓	
6.1.10	LOW FREQUENCY MODULATION OF THE RF OUTPUT		✓	

TABLE III

RF CHARACTERISTICS OF STANDARD MODELS

MODEL	BAND	FREQ GHz	MIN SAT PWR OUT dbm	DUTY CYCLE	MAX NOISE FIGURE db	SMALL SIG GAIN db	MAX INPUT-OUTPUT VSWR
LR620-10	L	1.0- 2.0	40	CW	--	30	- - -
SR620-10	S	2.0- 4.0	40	CW	30	35	2.5:1
SCR620-10	SC	3.7- 6.5	40	CW	--	30	- - -
CR620-10	C	4.0- 8.0	40	CW	30	40	2.5:1
CXR620-10	CX	7.0-11.0	40	CW	--	60	- - -
XR620-10	X	8.0-12.4	40	CW	30	40	2.5:1
KUR620-10	KU	12.4-18.0	40	CW	35	GAIN AT 10W -- 30	1.2:1
LR620-20	L	1.0- 2.0	43	CW	35	GAIN AT 20W -- 35	1.5:1
SR620-20	S	2.0- 4.0	43	CW	35	35	1.3:1
CR620-20	C	4.0- 8.0	43	CW	35	35	1.5:1
CXR620-20	CX	7.0-11.0	43	CW	35	35	1.5:1
XR620-20	X	8.0-12.4	43	CW	35	35	1.3:1
KUR620-20	KU	12.4-18.0	43	CW	--	--	1.2:1

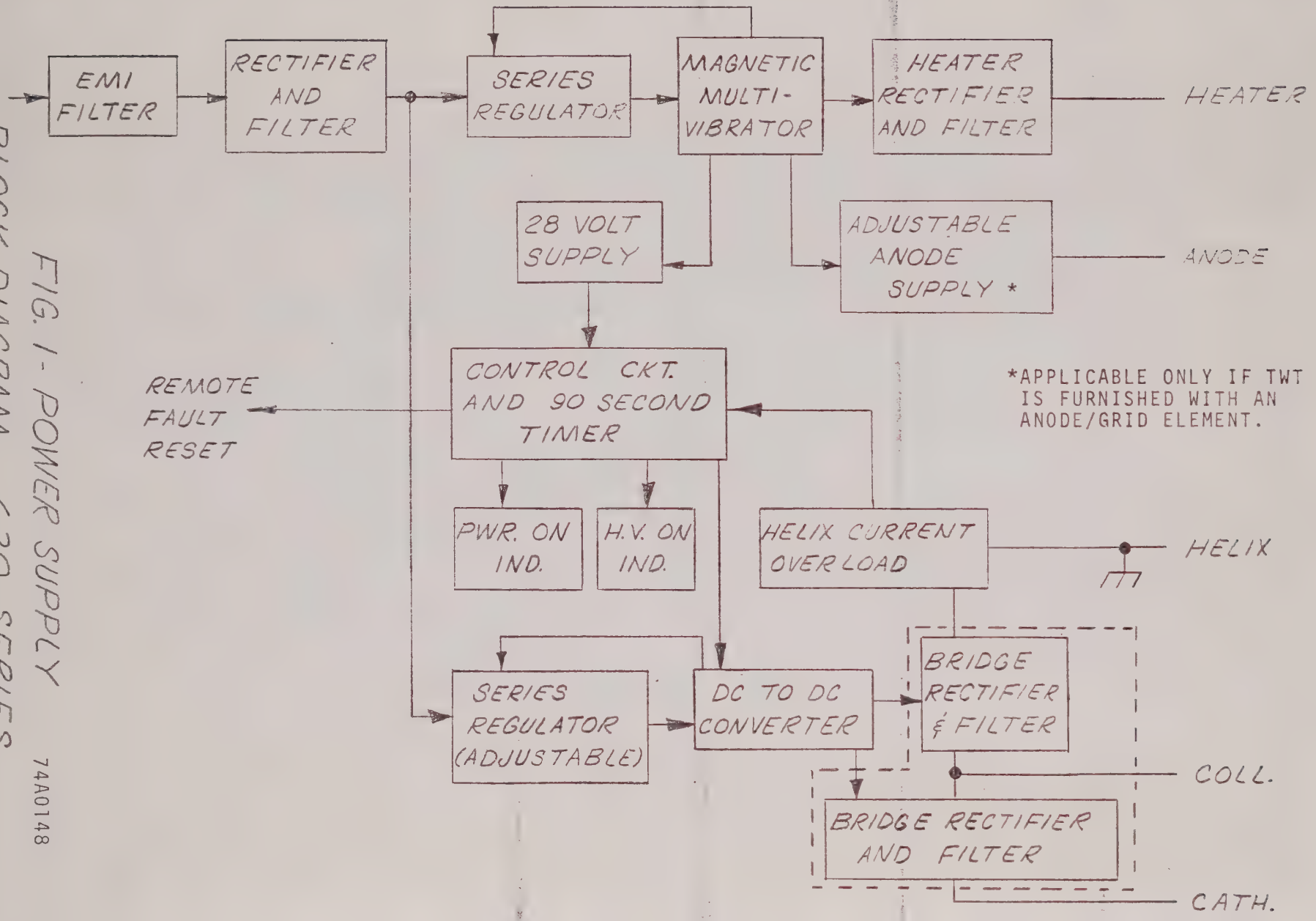
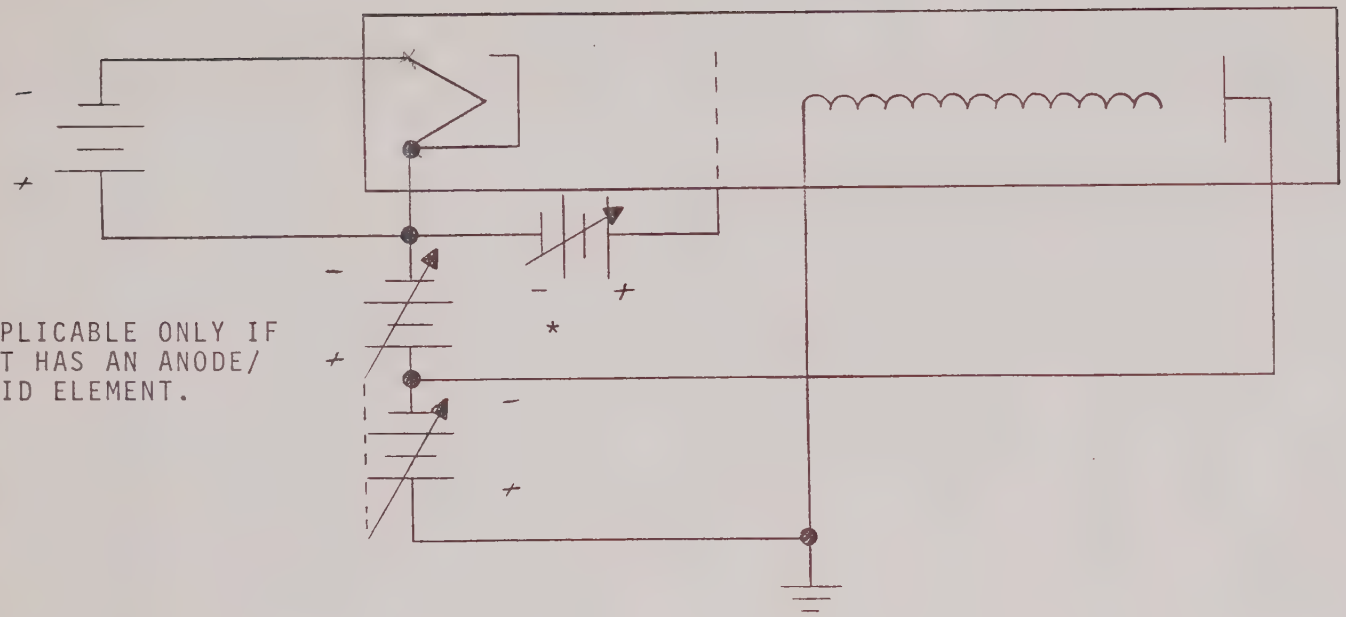


FIG. 1 - POWER SUPPLY 74A0148

BLOCK DIAGRAM - 620 SERIES

10 & 20 WATT AMPLIFIERS

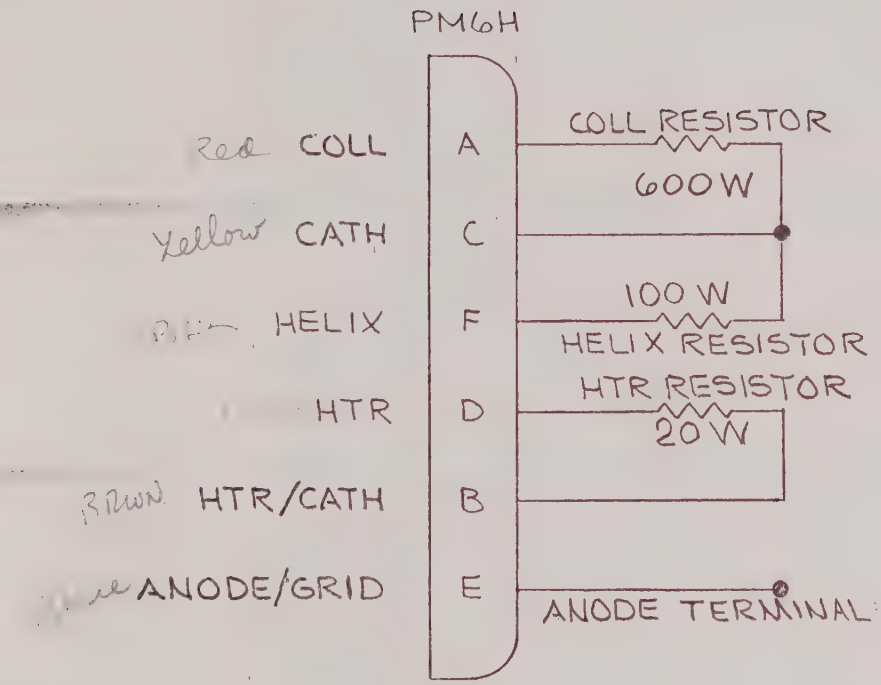
SH 43 OF 46



TWT - POWER SUPPLY
INTERFACE
FIG. 2

KELTEC FLORIDA
FORT WALTON BEACH, FLORIDA

SIZE	CODE IDENT NO	
A	09062	74A0148
SCALE	SHEET	REV
	44 of 46	



NOTES

THE RESISTORS MUST BE CAPABLE OF STANDING HIGH VOLTAGE.

*APPLICABLE ONLY IF TWT IS FURNISHED WITH AN ANODE/GRID ELEMENT.

FIGURE 3 - TEST LOAD FIXTURE

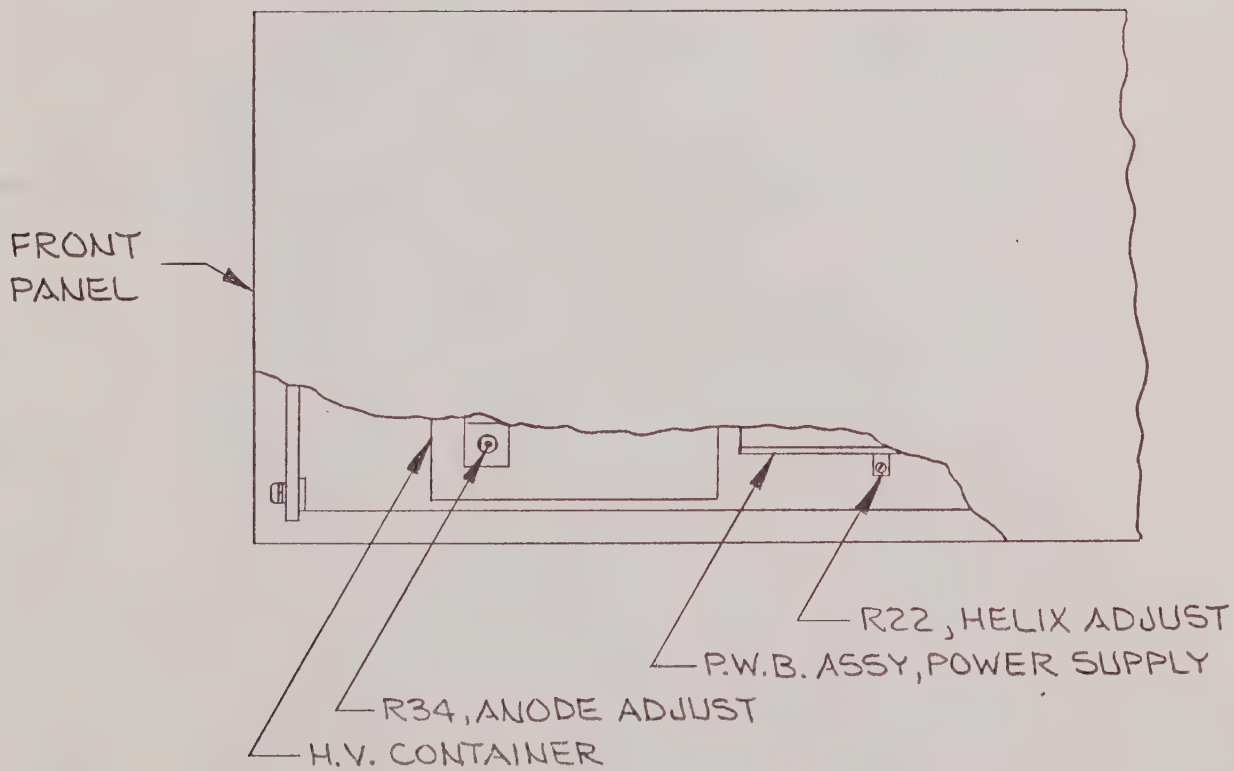


FIG. 4 - LOCATION OF VOLTAGE ADJUSTMENTS

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO 09062	74A0148
	SCALE	SHEET 46 of 46	REV

APPENDIX A

TWT RF AMPLIFIER DATA

MODEL _____ SERIAL NO. _____

TIME DELAY _____ SECONDS

NOISE POWER OUT _____ dbm

FREQUENCY	SAT POWER OUTPUT dbm	SMALL SIGNAL GAIN db

LINE REGULATION 103-121VRMS _____ (✓)

DATE _____ TESTED BY _____

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO 09062	74A0148
	SCALE	SHEET A1 of A1	REV

APPENDIX B

KELTEC FLORIDA WARRANTY

KELTEC FLORIDA WARRANTS EACH INSTRUMENT OF ITS MANUFACTURE TO BE FREE FROM DEFECT IN MATERIAL AND WORKMANSHIP. THE LIMIT OF LIABILITY UNDER THIS WARRANTY IS TO REPAIR OR REPLACE ANY INSTRUMENT OR PART THEREOF WHICH SHALL WITHIN ONE YEAR AFTER DELIVERY, TO THE ORIGINAL PURCHASER, AND RETURNED BY THE ORIGINAL PURCHASER, PROVE TO HAVE BEEN DEFECTIVE IN MATERIAL OR WORKMANSHIP AFTER EXAMINATION BY KELTEC FLORIDA. HOWEVER, THIS WARRANTY SPECIFICALLY EXCLUDES TRAVELING WAVE TUBES WHEREBY THE WARRANTY IS FOR 1,000 HOURS OPERATION (OR ONE YEAR PRORATED FROM 100 HOURS). IN CASES WHERE THE TRAVELING WAVE TUBE MANUFACTURER WARRANTS THE TUBE FOR LONGER PERIODS, KELTEC WILL PROVIDE THIS SAME WARRANTY. WARRANTY RETURNS MUST FIRST BE AUTHORIZED BY FACTORY OFFICE OR REPRESENTATIVE.

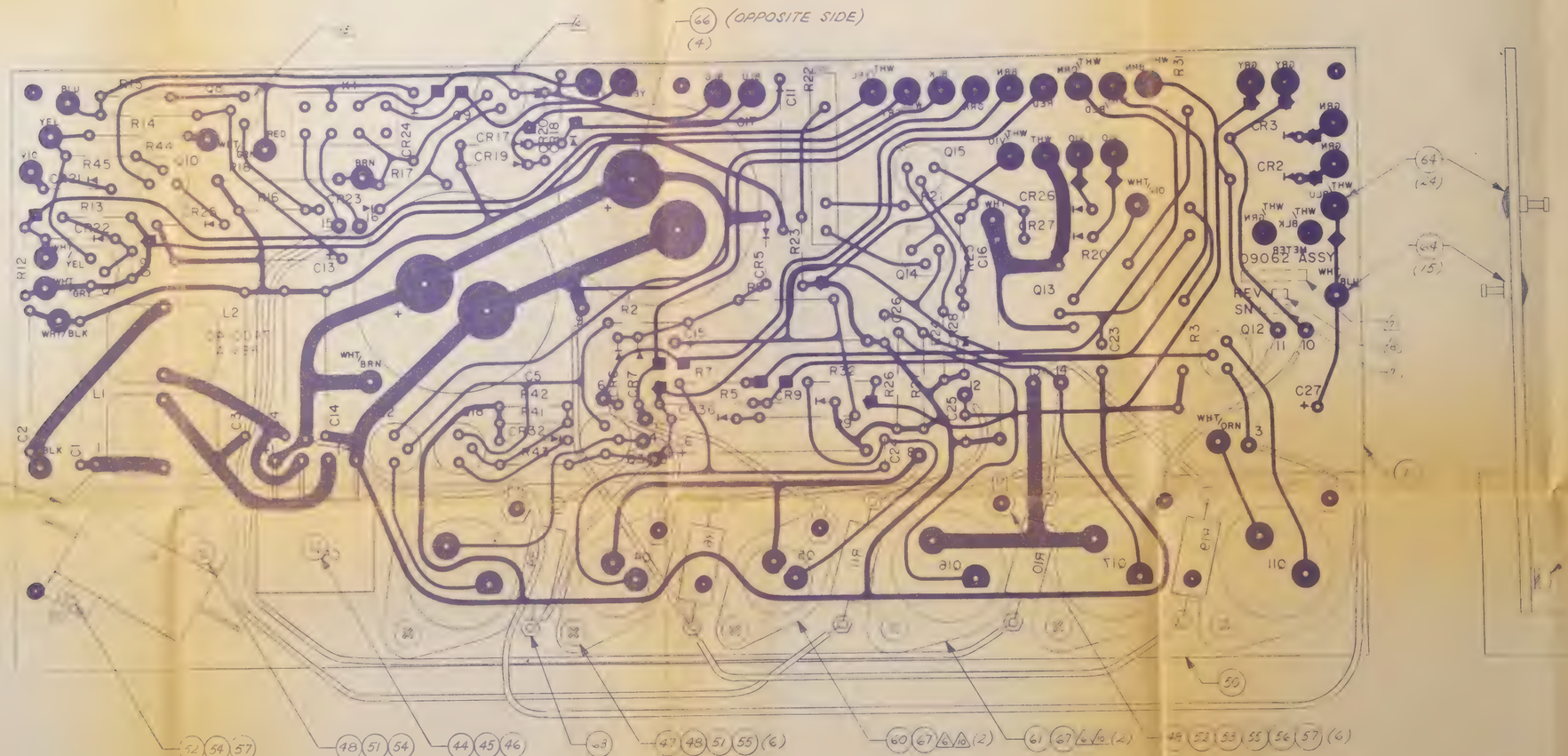
KELTEC FLORIDA ALSO RESERVES THE RIGHT TO MAKE CHANGES IN DESIGN ON ANY OF ITS PRODUCTS WITHOUT INCURRING ANY OBLIGATION TO MAKE THE SAME CHANGES ON UNITS PREVIOUSLY PURCHASED.

THIS WARRANTY IS THE EXTENT OF THE OBLIGATIONS OF LIABILITIES ASSUMED BY KELTEC FLORIDA WITH RESPECT TO ITS INSTRUMENTS, AND KELTEC FLORIDA NEITHER MAKES NOR AUTHORIZES ANY OTHER PERSON TO MAKE ANY OTHER GUARANTEE OR WARRANTY CONCERING THESE INSTRUMENTS.

APPENDIX C - DRAWINGS AND DIAGRAMS

PRINTED WIRING BOARD ASSEMBLY - ALL 74D0141

MODEL	PART NUMBER	SCHEMATIC	OUTLINE DRAWING
LR620-10	74D0344	74D0227	74D0173
SR620-10	74D0345	74D0229	74D0172
SCR620-10	74D0346	74D0226	74D0173
CR620-10	74D0347	74D0228	74D0172
CXR620-10	74D0348	74D0226	74D0173
XR620-10	74D0349	74D0231	74D0172
KUR620-10	74D0350	74D0224	74D0171
XR621-10	- - -	- - -	- - -
CR621-10	- - -	- - -	- - -
SR620-10	74D0278	74D0283	74D0275
CR620-10	74D0279	74D0286	74D0275
XR620-10	74D0280	74D0282	74D0275
CXR620-10	74D0276	74D0285	74D0275
CR620-10	74D0359	74D0228	74D0358
→ LR620-10	74D0360	74D0227	74D0358
SR620-10	74D0361	74D0229	74D0358
XR620-10	74D0362	74D0231	74D0358
LR620-20	74D0351	74D0221	74D0172
SR620-20	74D0352	74D0222	74D0172
CR620-20	74D0353	74D0222	74D0172
CXR620-20	74D0354	74D0223	74D0172
XR620-20	74D0355	74D0223	74D0172
KUR620-20	74D0356	74D0224	74D0171
XR621-20	74D0357	74D0225	74D0172
CR621-20	74D0277	74D0284	74D0275



NOTES:

1. COMPONENT ASSY & MTG TECHNIQUES PER MIL-STD-275.
2. ALL RESISTORS WITH VALUE OF 1 WATT OR MORE WILL BE MOUNTED 1/16 ABOVE SURFACE OF P.W. BOARD.
3. FOR SCHEMATIC SEE DWG.
4. INSTALL ITEM 59 UNDER ITEMS 3, 4 & 6.
5. INSTALL ITEM 58 UNDER ITEM 7.
6. FOR TRANSISTOR MTG TECHNIQUE SEE DWG 72A0817.
7. APPLY APPROPRIATE DWG NO. AND DASH LEVEL IN APPROX AREA SHOWN.
8. APPLY APPROPRIATE REV LEVEL IN APPROX AREA SHOWN.
9. APPLY APPROPRIATE SERIAL NO. IN APPROX AREA SHOWN.
10. APPLY AN EVEN FILM OF ITEM 67 TO THE MOUNTING SURFACE OF EACH TRANSISTOR & HEATSINK.

			MATERIAL
			FINISH
REF	R620-10/20		
QTY.	USED ON	NEXT ASSY.	
APPLICATION			

EXCEPT AS MAY BE OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF KELTEC FLA. ARE ISSUED IN STRICT CONFIDENCE AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT PERMISSION.

-3 QTY. REQ'D.	-2 QTY. REQ'D.	-1 QTY. REQ'D.	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
						LIST OF MATERIALS		

INTERPRET DRAWINGS IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES

TOLERANCES

BASIC DIMENSION	DECIMALS 2 PLACE	DECIMALS 3 PLACE	FRACTIONS
UNDER 6	± .01	± .005	± 1/64
6-24 INCL.	± .02	± .010	± 1/32
OVER 24	±	± .015	± 1/16
ANGLES ± 1/2			

APPROVALS, SIGNATURE & DATE	
DRAWN	FAS 3-25-74
CHECKED	F.E.S. 4-3-74
DWG. SUP.	M. Smyth
MECH.	
ENGR.	F Dutton
ENGR.	
PROJ. APPD.	

KELTEC, FLORIDA
FORT WALTON BEACH, FLORIDA

PRINTED WIRING BOARD ASSY
POWER SUPPLY BOARD

SIZE	CODE IDENT	
D	09062	74D0141

SCALE NONE | SHEET 1 OF 2

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD

HIGH VOLTAGE

P.W.B. — HV
74D0326

P.W.B. H.S.

HEAT SINK

NOTES

1. UNLESS OTHERWISE SPECIFIED :
   ALL RESISTOR VALUES ARE 1/4 W AND IN OHMS.
   ALL CAPACITOR VALUES ARE IN MICROFARADS AND VOLTS.
2. HV BOARD JUMPERS: 24-22-26, 25-6, 6-19, 12-18

COMPONENT INDEX

LAST USED		DELETED
Q19	DS2	CR2-4, 8, 16, 30-34
C32	S1	Q13
R56	P1	C8-10, 23, 27, 20
CR41		R3, 20, 31, 33-35
K1		C28, 30 31
T2		
L3		
CB1		
BL1		

REF	LR620-10	
QTY.	USED ON	NEXT ASSY.
APPLICATION		

MATERIAL

FINISH

EXCEPT AS MAY BE OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF KELTEC FLA. ARE ISSUED IN STRICT CONFIDENCE AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT PERMISSION.

INTERPRET DRAWINGS IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES

TOLERANCES

BASIC DIMENSION	DECIMALS 2 PLACE	DECIMALS 3 PLACE	FRACTIONS
UNDER 6	± .01	± .005	± 1/64
6-24 INCL.	± .02	± .010	± 1/32
OVER 24	±	± .015	± 1/16
ANGLES ± 1/2			

APPROVALS, SIGNATURE & DATE	
DRAWN	B GARDNER 3-14-74
CHECKED	FLEISCHMAN
DWG. SUP.	
MECH.	
ENGR.	
ENGR.	
PROJ. APPD.	

KELTEC, FLORIDA
FORT WALTON BEACH, FLORIDA

SCHEMATIC
LR620-10

SIZE	CODE IDENT	
D	09082	74D0227

SCALE NONE | SHEET

-3	-2	-1	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
QTY. REQ'D.								

LIST OF MATERIALS

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD

-3	-2	-1	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
QTY. REQ'D.								
		1	1		74C0140-1	PRINTED WIRING BOARD		
		1	2		DTS411	TRANSISTOR		Q11
		2	3		2N3440			Q8,9,14,15,16
		2	4		2N2219A			Q3,6
		2	5		2N3585			Q4,5
		2	6		2N2323			Q7,8
		1	7		2N4949			Q2
		2	8		2N697	TRANSISTOR	MOTOROLA	Q1,10,17
		1	9		MLA270-3	DIODE BRIDGE	MOTOROLA	CR1
		15	10		IN644	DIODE	CR5-7,9,17-21,23-27,36	
		2	11		IN754A	DIODE		CR31,33
		1	12		IN936B	DIODE		CR28
		5	13		31-104D	CAPACITOR, .1uf, 400V		C1-4,14
		1	14		36E431F200AB2A	430uf, 200V		C5,17
		2	15		M39018/01-0769	5.6uf 250V		C6,12,16
		3	16		CL65BJ470MPE	47uf, 50V		C11
		1	17		CKR06BX104K	.1uf, 100V		C13
		1	18		CL65XXXXXMPE	(SIT)		C34
		1	19		CL65BH151MPE	150uf, 30V		C19
		2	20		CK06BX224M	CAPACITOR, .22uf, 50V		C35,36
		1	21		RTI6C2P202K	RESISTOR 2K (POT)		R38
		1	22		RH25	.33Ω, 25W		R1
		2	23		RWR91W1R0	1Ω, 3W		R46
		2	24		RWR91VXXX	(SIT), 3W		R15,17
		1	25		RWR91VR33	.33Ω 3W		R19
		2	26		RLR20C1224JR	120K, 1/2W		R2,8
		1	27		RLR20C104JR	100K		R5
		2	28		RLR20C6802JR	6.8K		R9,44
		1	29		RLR20C274JR	270K		R14
		2	30		RLR20C2702JR	27Ω 1/2W		R4,37
		1	31		RLR07C471JR	470Ω, 1/4W		R7,35
		2	32		RLR07CXXXJR	(SIT)		R10,41
		3	33		RLR07C102JR	1K		R13,15,17
		1	34		RLR07C560JR	56Ω 1/4W		R16
		1	35		RLR32C272JM	2.7K, 1W		R18
		2	36		RLR07C122JR	1.2K, 1/4W		R21,25
		1	37		RLR07C332JR	3.3K		R23
		1	38		RLR07C472JR	4.7K		R24
		1	39		RLR07C183JR	18K		R42
		1	40		RLR07C154JR	150K		R43
		1	41		RLR07C103JR	RESISTOR 10K 1/4W		R45
		2	42		73T0122	INDUCTOR		L1,2
		1	43		M5757/9-003	RELAY	MIL-R-5757/9	K1
		1	44		MS35338-136	WASHER, SPLIT-LOCK, NO. 6		
		1	45		MS15795-805	WASHER, FLAT, NO. 6		
		1	46		MS51957-30	SCREW, PH 6-32 X 1/2		
		6	47		MS51957-16	SCREW, PH 4-40 X 7/16		
		1	48		MS35338-135	WASHER, SPLIT-LOCK, NO. 4		

-3	-2	-1	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	NOTES
QTY. REQ'D.								
		AR	67		72A0753-1	HEAT SINK COMPOUND		
		4	66		MS35649-???	WASHER, INT-LOCK, NO. 10		
		AR	65		TRA-BOND BA-2129	GLUE, EPOXY	TRA-CON INC CAMBRIDGE	
		39	64		2C3-3	TERMINAL, TURRET	CAMBION	
		10	63		4870-1-0516	TERMINAL, INSULATED	CAMBION	
		AR	62		E22, WHT	WIRE, TYPE E, INSULATED	MIL-W-16878/4	
		4	61		72A0007-1	INSULATOR		
		2	60		72A0010-1	INSULATOR		
		4	59		7717-5 CAP	TRANSIPAD	MIL-M-14F	
		1	58		7717-117N	TRANSIPAD	MIL-M-14F	
		7	57		MS35333-70	WASHER, INT LOCK, NO. 4		
		6	56		MS51957-18	SCREW, PH 4-40 X 5/8		
		12	55		2534	BUSHING, NYLON	H.H. SMITH	
		5	54		MS51957-13	SCREW, PH 4-40 X 1/4		
		6	53		MS35649-244	NUT, HEX, 4-40		
		7	52		MS[illegible]-1	LUG, SOLDER, NO. 4		
		10	51		MS15795-803	WASHER, FLAT, NO. 4		
		1	50		73C0207-1	HEAT SINK		
		AR	49		SN60 WRAP 3	SOLDER	QQ-S-571	

LIST OF MATERIALS

			MATERIAL
			FINISH
REF	R620-10/20		
QTY.	USED ON	NEXT ASSY.	
APPLICATION			

EXCEPT AS MAY BE OTHERWISE PROVIDED IN CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF KELTEC, FLORIDA AND ISSUED IN STRICT CONFIDENCE AND SHALL NOT BE REPRODUCED, OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OF SIMILAR APPARATUS WITHOUT PERMISSION.

INTERPRET DRAWINGS IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES

TOLERANCES			
BASIC DIMENSION	DECIMALS 2 PLACE	DECIMALS 3 PLACE	FRACTIONS
UNDER 6	± .01	± .005	± 1/64
6-24 INCL.	± .02	± .010	± 1/32
OVER 24	±	± .015	± 1/16
ANGLES ± 1/2			

APPROVALS, SIGNATURE & DATE	
DRAWN	
CHECKED	
DWG. SUP.	
MECH.	
ENGR.	F. Dutton
ENGR.	
PROJ. APPD.	

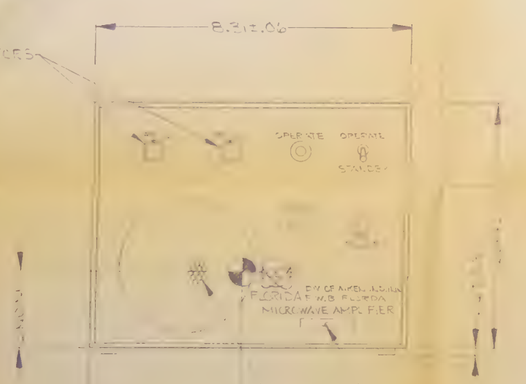
KELTEC, FLORIDA
PORT WALTON BEACH, FLORIDA

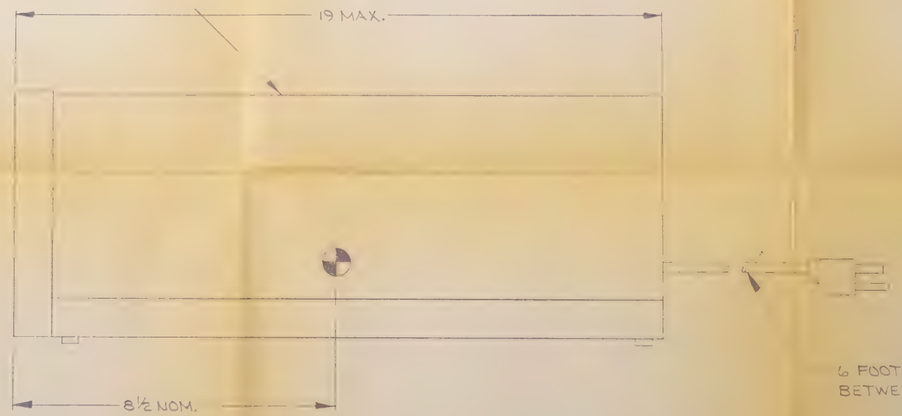
PRINTED WIRING BOARD ASSY POWER SUPPLY BOARD

SIZE	CODE IDENT	
D	09062	74C0140

SCALE NONE SHEET 2 OF 2

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD





NOTES

1. UNIT WEIGHT 19.5 LBS NOM.

-3	-2	-1	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
QTY. REQ'D.								

LIST OF MATERIALS

REF	XPL2X-0		
REF	SRL2C-1C		
REF	LRL2C-1C		
REF	CRL2C-1C		
QTY.	USED ON	NEXT ASSY.	

APPLICATION

MATERIAL

FINISH

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INTERPRET DRAWINGS IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES

TOLERANCES

BASIC DIMENSION	DECIMALS 2 PLACE	DECIMALS 3 PLACE	FRACTIONS
UNDER 6	± .01	± .005	± 1/64
6-24 INCL.	± .02	± .010	± 1/32
OVER 24	±	± .015	± 1/16
ANGLES ± 1/2			

APPROVALS, SIGNATURE & DATE	
DRAWN	JCM 4-22-74
CHECKED	FLEISCHMAN 4/23/74
DWG. SUP.	
MECH.	
ENGR.	
ENGR.	
PROJ. APPD.	

KELTEC, FLORIDA
FORT WALTON BEACH, FLORIDA

OUTLINE DRAWING

SIZE	CODE IDENT	
D	09062	74D0358

SCALE 1/2 SHEET

APPENDIX A

TWT RF AMPLIFIER DATA

MODEL SR620-10 SERIAL NO. 4471/015

TIME DELAY 65.0 SECONDS

NOISE POWER OUT 7.0 dbm

FREQUENCY	SAT POWER OUTPUT dbm	SMALL SIGNAL GAIN ldb
2.0	40.8	32.6
2.2	42.5	35.7
2.4	43.4	36.7
2.6	44.0	38.6
2.8	44.4	38.3
3.0	44.4	38.1
3.2	44.1	37.3
3.4	44.0	36.9
3.6	43.3	35.3
3.8	42.3	33.0
4.0	41.2	30.8

LINE REGULATION 103-121VRMS ✓ (✓)

DATE 6-26-74 TESTED BY Sam Mayfield

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO. 09062	74A0574
	SCALE	SHEET A1 of 1	REV

APPENDIX A

TWT RF AMPLIFIER DATA

MODEL SR620-10 SERIAL NO. 4471/015

TIME DELAY 65.0 SECONDS

NOISE POWER OUT 7.0 dbm

FREQUENCY	SAT POWER OUTPUT dbm	SMALL SIGNAL GAIN db
2.0	40.8	32.6
2.2	42.5	35.7
2.4	43.4	36.7
2.6	44.0	38.6
2.8	44.4	38.3
3.0	44.4	38.1
3.2	44.1	37.3
3.4	44.0	36.9
3.6	43.3	35.3
3.8	42.3	33.0
4.0	41.2	30.8

LINE REGULATION 103-121VRMS ✓ (✓)

DATE 6-26-74 TESTED BY Sam Mayfield

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO. 09062	74A0574
	SCALE	SHEET 41 of 111	REV

APPENDIX A

TWT RF AMPLIFIER DATA

MODEL SR620-10 SERIAL NO. 4471/015

TIME DELAY 65.0 SECONDS

NOISE POWER OUT 7.0 dbm

FREQUENCY	SAT POWER OUTPUT dbm	SMALL SIGNAL GAIN db
2.0	40.8	32.6
2.2	42.5	35.7
2.4	43.4	36.7
2.6	44.0	38.6
2.8	44.4	38.3
3.0	44.4	38.1
3.2	44.1	37.3
3.4	44.0	36.9
3.6	43.3	35.3
3.8	42.3	33.0
4.0	41.2	30.8

LINE REGULATION 103-121VRMS ✓ (✓)

DATE 6-26-74 TESTED BY Sam Mayfield

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO. 09062	74A0574
	SCALE	SHEET A1 of 1	REV

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TEST PERFORMANCE SHEET

TRAVELING WAVE TUBE
TUBE TYPE NO. VTC-6069A1
SERIAL NO. 6304 DATE 4-10-78
Page 1 of 1

TWT ACCEPTANCE TEST DATA

OPERATING CONDITIONS[1]

TWT TEST	SYMBOL	MIN	MAX	RESULT	UNITS
Heater Voltage[2]	Ef	---	---	6.3	V
Heater Current	If	0.35	0.65	.360	A
Helix Voltage (Label Value)	Ew	2600	2900	2760	Vdc
Helix Current (1) No Drive	Iw	---	10	.5	mAdc
Helix Current (2) Sat Drive at 4 GHz	Iw	---	10	1.0	mAdc
Collector Voltage	Eb	1500	2900	1500	V
Cathode Current	Ik	---	85	62.0	mAdc
Grid Voltage	Ec	Ew+	300	40.0	Vdc
Grid Current	Ic	---	1	.05	mAdc
Power Output: Saturation 4-8 GHz	Po	40	---	See Table	dBm
Gain at 40 dBm (10w) Output	G	45	---	See Table	db

1. Voltages are with respect to cathode.
2. If dc heater voltage is used on this tube, the heater must be negative with respect to the heater-cathode.

Freq. (GHz)	Sat Po (dBm)	Gain At 40 dBm
4.0	42.0	51.0
4.5	41.6	56.5
5.0	42.8	62.0
5.5	42.5	63.4
6.0	42.6	64.0
6.5	43.2	62.2
7.0	42.4	61.0
7.5	42.5	59.6
8.0	42.4	58.0

LEAD CONNECTIONS

Heater Cathode	-	Yellow
Heater	-	Brown
Grid	-	Blue
Collector	-	Red
Helix/Capsule	-	Base

TUBE TYPE	OUTLINE DWG. NO.
VTC-6069A1	146448

TESTED BY: D. King DATE: 4-10-78 VARIAN QA: J. GRAF QA

OUTPUT VARIES MODEX 2DB
CONSTANTS E

WARRANTY CLAIM FORM
FOR
MICROWAVE TUBES, POWER SUPPLIES AND COMPONENTS

PROPER COMPLETION OF THIS FORM IS VITALLY IMPORTANT TO THE PROMPT AND EFFICIENT HANDLING OF PRODUCT WARRANTY CLAIMS.

I. This claim form, properly completed, must accompany any returned Product and be received by Varian's Palo Alto Microwave Tube Division prior to expiration of the adjustment period. Compliance with this requirement assures the user of the most prompt and thorough service possible. A Product returned within the adjustment period, but without the completed Warranty Claim Form, will be treated as out of warranty.

II. Complete the following information regarding the Product being returned:

A. Product Type: Varian Part No._____ Serial No._____

Customer Part No._____

B. Customer Purchase Order No._____

Date of Purchase Order _____

C. Control Specification Number _____ Dated _____

(Check one) Document of VA ☐ your company ☐

D. Contract Warranty (either Varian Warranty code or specification paragraph)

_____

Filament Hours _____ Warranty Adjustment Began_____

Adjustment Time _____ (months) Expires_____

III. Claim is made against warranty based on the following:

A. Specification(s) not met by the Product (list by specification and paragraph number):

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PLEASE FILL IN FOR FAILED PRODUCTS

(Place an "X" in the appropriate box to show what variance from normal was seen at the time of tube failure.)

* Product Serial No. / Type No.	Date Installed	Date Failed	Filament Hours	Radiate Hours	Filament Current		Beam Current		Helix or Body Current		Hi Voltage Arcs		W/G Arcs		Coolant Flow		Mech. Problems		Electro-Magnet Current	
					Lo	Hi	Lo	Hi	Nml	Hi	No	Yes	No	Yes	Nml	Lo	No	Yes	Nml	Lo

*It is necessary to have the Product serial number rather than the system serial number.

B. Describe the circumstances and/or sequence of events under which the Product failed. Include remarks relating to installation problems, system anomalies, etc.

IV. System used in _____

Serial No. _____

V. Purchaser's Name _____

Address _____

_____

Claim made by: _____

Person to contact for additional information:

Name _____

Telephone _____

_____
(Signature)

_____
(Date)

Return completed form promptly, with Product, to:

Varian Associates, Inc.
Palo Alto Microwave Tube Division
Building 2 Receiving
611 Hansen Way
Palo Alto, California

Telephone: (415) 493-4000
TWX: 910-373-1731

Attention: Returned Tubes and Products

RETURN PROCEDURES

WARRANTY CLAIM

All claims under warranty must be made promptly after occurrence of circumstances giving rise to the claim and must be received within the applicable warranty period by Varian or its authorized representative. Varian reserves the right to reject any warranty claim not promptly reported. After expiration of the applicable warranty period, Microwave Tubes, Power Supplies and Components are not subject to adjustment.

Unnecessary expense and loss of time often can be avoided by calling the local Varian Field Office before returning a Product to the factory. Returned Products are frequently found to be within performance specifications required of new Products. The Varian representative may be able to determine the trouble and obtain satisfactory performance from the Product. This may save shipping time and expense and minimize equipment down time.

WARRANTY CLAIM FORM

Before any Product is returned for repair and/or adjustment, written authorization from Varian for the return and instructions as to how and where the Product should be shipped must be obtained. The Product type and serial numbers and a full description of the circumstances giving rise to the warranty claim should be included. Such information will help establish the cause of failure and expedite adjustment or repair. For this purpose, a **Warranty Claim Form** is shipped with each Product.

IMPORTANT

Any Product returned without a completed claim form will be considered to have met all contractual requirements. Both the Product and the completed claim form must be submitted to Varian Associates, Inc. prior to expiration of the applicable warranty period.

TRANSPORTATION AND PACKAGING

Any Product returned to Varian for examination must be sent prepaid via the means of transportation indicated as acceptable by Varian. Varian reserves the right to reject any warranty claim on any item that has been altered or has been shipped by nonacceptable means of transportation. Returned Products should be carefully packed in the original container, and unless otherwise indicated, shipped to:

VARIAN ASSOCIATES, INC.
Palo Alto Microwave Tube Division
Building 2, Receiving
611 Hansen Way
Palo Alto, California 94303

Attn: Returned Tubes and Products

AUTHORIZATION FOR EVALUATION

When any Product is returned for examination and inspection, or for any other reason, Customer and its shipping agency shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or nonconformity in the Product. By returning a Product, the owner grants Varian Associates, Inc. permission to open and disassemble the Product as required for evaluation. In all cases Varian has sole responsibility for determining the cause and nature of failure, and Varian's determination with regard thereto shall be final.

If it is found that Varian's Product has been returned without cause and is still serviceable, the Customer will be notified and the Product returned at its expense; in addition, a charge for testing and examination may, in Varian's sole discretion, be made on Products so returned.

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WARRANTY

MICROWAVE TUBES, POWER SUPPLIES AND COMPONENTS
PALO ALTO MICROWAVE TUBE DIVISION OF VARIAN ASSOCIATES, INC.

WARRANTY

Microwave Tubes, Power Supplies, and Components ("Products") sold by Varian are warranted against defects in workmanship and material when used under normal operating conditions within the respective Varian specified ratings and in accordance with Varian operating instructions. The applicable Microwave Tube warranty period shall commence on the date of shipment from Varian and extend for a specified number of hours of operation of the filament or heater, or for a specified number of months following the date of shipment thereof, whichever first occurs. The applicable number of hours of operation of the filament or heater included in the warranty for a Microwave Tube depends upon the type of tube. The most common periods of warranty are listed below:

CODES		
Warranty Code	Warranted Filament or Heater Operation (hours)	Maximum Adjustment Period (months)
GROUP A		
W-U	Unlimited	12
W-1000	1000	12
W-2000	2000	12
W-5000	5000	12
W-7500	7500	24
GROUP B		
C-1	N/A	12
	Non-Pro Rata Period (Months)	Pro Rata Period (Months)
GROUP C		
W-12	4	12
W-18	6	18
W-24	6	24
W-36	6	36

ADJUSTMENTS

Repair, or at Varian's option, replacement of the Product or defective parts therein shall be the sole and exclusive remedy under valid warranty claims; provided that Varian may, as an alternative, elect to refund an equitable portion of the purchase price of the Product in accordance with the following adjustment criteria.

If a Microwave Tube in Group A fails from causes covered by this warranty within the warranted hours of operation and maximum adjustment period, a pro rata adjustment, based on the selling price, will be made as follows:

$$\text{Adjustment} = (\text{Applicable Selling Price}) \times \left[\frac{(\text{Warranted Hours} - \text{Hours of Operation at Failure})}{\text{Warranted Hours}}\right]$$

Power Supplies and passive Components in Group B, including electromagnets, solenoids, filters, waterloads, circulators, couplers, waveguide windows, diplexors, and other passive devices are warranted for unlimited hours of operation during the one year period following date of shipment thereof.

If a unit in Group C fails from causes covered by this warranty within the warranted period of operation, an adjustment based on selling price will be made as follows:

(1) $$\text{Adjustment} = (\text{Applicable Selling Price}) \times \frac{\text{Warranted Period} - \text{Months of Operation at Failure}}{\text{Warranted Period}}$$

(2) Except the non-pro rata period shall be a 100% adjustment.

No adjustment will be made for failure beyond the warranted hours of operation or beyond the maximum adjustment period. In all cases failure shall be deemed to have occurred no more than seven days before the first date on which notice of failure is received by Varian.

Varian shall have no obligations under this warranty unless the applicable warranty period (number of hours of operation of the filament or heater, and/or number of months from date of shipment) is specified on Varian's quotation, or is otherwise agreed to in writing by Varian. In the event Customers and/or users of any Microwave Tube subject to warranty claim fail to keep accurate records of the number of hours of operation of the filament or heater, Varian, in its sole discretion, may reject any such claim or determine probable usage of the Product.

This warranty is expressly in lieu of and excludes all other express or implied warranties, including but not limited to warranties of fitness for particular purpose, use or application, and all other obligations or liabilities on the part of Varian, unless such other warranties, obligations or liabilities are expressly agreed to in writing by Varian.

LIABILITIES

Varian's aggregate liability for damages shall not exceed the payment, if any, received by Varian for the unit of Product or service furnished or to be furnished, as the case may be, which is the subject of claim or dispute. In no event shall Varian be liable for incidental, consequential or special damages. Liability to third parties for bodily injury, including death, resulting from Varian's performance shall be determined in accordance with applicable law, and the total liability limitation stated above shall not be construed as a limitation on Varian for damages for any such bodily injury, including death. No action, regardless of form, arising out of, or in any way connected with, Products or services furnished by Varian, may be brought by Customer more than one (1) year after the cause of action has accrued. All patent liability of Varian shall be determined solely in accordance with the standard Terms and Conditions of Sale, Electron Device Group, Varian Associates, Inc.

Pub. No. 3187 6/77 Printed in U.S.A.

PALO ALTO MICROWAVE TUBE DIVISION • 611 HANSEN WAY • PALO ALTO, CALIFORNIA 94303

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OPERATING HAZARDS

READ THIS SHEET AND TAKE ALL SAFETY PRECAUTIONS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO MICROWAVE TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. VARIAN PROVIDES INFORMATION ON ITS PRODUCTS AND ASSOCIATED HAZARDS, BUT IT ASSUMES NO RESPONSIBILITY FOR AFTER-SALE OPERATING AND SAFETY PRACTICES. LIMITED LIFE AND RANDOM FAILURES ARE INHERENT CHARACTERISTICS OF ELECTRON TUBES. TAKE APPROPRIATE ACTION THROUGH REDUNDANCY OR OTHER SAFEGUARDS TO PROTECT PERSONNEL AND PROPERTY FROM TUBE FAILURE.

ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO MICROWAVE TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

OPERATING INSTRUCTIONS

This sheet, the Test Performance Sheet and the Operating Instructions can help you to operate this tube safely and efficiently. READ THEM. The Test Performance Sheet is a record of individual product test conditions and test results at the factory. Special operating considerations and precautions will be found in the Operating Instructions. Uninformed or careless operation of this tube can result in poor performance, damage to the tube or other property, serious bodily injury and, possibly death.

Address written questions regarding tube operation to the Manager, Tube Sales, at the address at the bottom of this sheet.

WARNING – SERIOUS HAZARDS EXIST IN THE OPERATION OF MICROWAVE TUBES

The operation of microwave tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE – Normal operating voltages can be deadly.
b. RF RADIATION – Exposure to rf radiation may cause serious bodily injury possibly resulting in blindness or death. **Cardiac pacemakers may be affected.**
c. X-RAY RADIATION – High voltage tubes can produce dangerous, possibly fatal, x-rays.
d. BERYLLIUM OXIDE POISONING – The dust or fumes from beryllium oxide (BeO_2) ceramics used in microwave tubes are highly toxic and can cause serious injury or death.
e. CORROSIVE AND POISONOUS COMPOUNDS – Upon microwave or high voltage breakdown in the external waveguide portion of microwave tubes, a dielectric gas is sometimes used which may combine with impurities to form highly toxic and corrosive compounds.
f. IMPLOSION HAZARD – Ceramic windows in microwave tubes can shatter on impact or crack in use, possibly resulting in injury from flying particles or from beryllium oxide (BeO_2) dust or fumes.
g. HOT WATER – The electron collector and water used to cool it reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.
h. HOT SURFACES – Surfaces of air-cooled collectors and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

Additional specific information about microwave tube hazards:

HIGH VOLTAGE

Many microwave tubes operate at voltages high enough to kill through electrical shock. Design equipment utilizing these tubes to prevent personnel contact with high voltages. Securely attach prominent hazard warnings. Personnel should always break the primary circuits of the power supply and discharge high voltage condensers when direct access to the tube is required.

RADIO FREQUENCY RADIATION

EXPOSURE OF PERSONNEL TO RF RADIATION SHOULD BE MINIMIZED. PERSONNEL SHOULD NOT BE PERMITTED IN THE VICINITY OF OPEN ENERGIZED WAVEGUIDES OR ENERGIZED ANTENNAS. It is generally accepted that exposure to "high levels" of rf radiation can result in severe bodily injury including blindness. **Cardiac pacemakers may be affected.**

The effect of prolonged exposure to "low-level" rf radiation continues to be a subject of investigation and controversy. While there continues to be support for lower limits, it is generally agreed among official standard-setting groups in the U.S. that prolonged exposure of personnel to rf radiation at frequencies of 10 MHz – 100 GHz should be limited to average power densities of ten milliwatts per square centimeter (10 mW/cm^2) or lower, using any possible one tenth of an hour (.1 hour) as the averaging period. It is also generally agreed that exposure should be reduced in working areas where temperatures are above normal. The 10 mW/cm^2 average level has been adopted by several U.S. Government agencies including the Occupational Safety and Health Administration (OSHA) as the standard or protection guide for employee work places.

ALL INPUT AND OUTPUT RF CONNECTIONS, WAVEGUIDES, FLANGES AND GASKETS MUST BE RF LEAKPROOF. NEVER OPERATE A MICROWAVE TUBE WITHOUT A PROPERLY MATCHED RF ENERGY ABSORBING LOAD ATTACHED. NEVER LOOK INTO OR EXPOSE ANY PART OF THE BODY TO AN ANTENNA OR OPEN WAVEGUIDE WHILE THE TUBE IS ENERGIZED. MONITOR THE TUBE AND RF SYSTEM FOR RF RADIATION LEAKAGE AT REGULAR INTERVALS AND AFTER SERVICING.

X-RAY RADIATION

As voltages increase beyond 15 kilovolts metal-body tubes are capable of producing progressively more dangerous X-ray radiaiton. Provide adequate X-ray shielding on all sides of these tubes, particularly the cathode and collector ends, as well as the modulator and pulse transformer tanks. Check X-ray levels. NEVER OPERATE HIGH VOLTAGE TUBES WITHOUT ADEQUATE X-RAY SHIELDING IN PLACE. MONITOR THE TUBE AFTER SERVICING AND AT REGULAR INTERVALS FOR POSSIBLE CHANGES IN X-RAY LEVELS DUE TO AGING.

DANGER – BERYLLIUM OXIDE CERAMICS (BeO_2) – AVOID BREATHING DUST OR FUMES

Some microwave tubes contain beryllium oxide (BeO_2) ceramics; usually the output waveguide window or around the cathode. Do not perform any operations on BeO_2 ceramics which produce dust or fumes; for example, grinding, grit blasting, and acid cleaning. BERYLLIUM OXIDE DUST AND FUMES ARE HIGHLY TOXIC AND BREATHING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. If a broken window is suspected, carefully remove the tube from its waveguide and seal the output flange of the tube with tape. Because BeO_2 warning labels may be obliterated or removed, we urge you to contact Varian before performing any work on ceramics in any Varian microwave tube.

Take precautions to protect personnel working in the disposal or salvage of tubes containing BeO_2. All such personnel should be made aware of the deadly hazards involved and the necessity for great care and attention to safety precautions. Varian will dispose of tubes without charge provided they are returned to Varian freight prepaid, with a written request for disposal by Varian.

CORROSIVE AND POISONOUS COMPOUNDS

External output waveguides and cathode high voltage bushings of microwave tubes are sometimes operated in systems that use a dielectric gas to impede microwave or high voltage breakdown. If breakdown does occur, the gas may decompose and combine with impurities, such as air or water vapor, to form highly toxic and corrosive compounds. Examples are Freon gas which may form LETHAL PHOSGENE, and sulfur hexafluoride (SF_6) gas which may form highly toxic and corrosive sulfur or fluorine compounds such as BERYLLIUM FLUORIDE. When breakdown does occur in the presence of these gases, VENTILATE THE AREA, AVOID BREATHING ANY FUMES OR TOUCHING ANY LIQUIDS WHICH DEVELOP, TAKE PRECAUTIONS APPROPRIATE FOR BERYLLIUM COMPOUNDS AND FOR OTHER HIGHLY TOXIC AND CORROSIVE SUBSTANCES, before permitting personnel to perform any work on or near the tube.

IMPLOSION HAZARD

Due to the internal vacuum in microwave tubes the glass or ceramic output window can shatter inward (implode) if struck with a hard object or subjected to mechanical shock. Flying debris could result in bodily injury, including cuts and puncture wounds and, if made of BERYLLIUM OXIDE ceramic, produce highly toxic dust or fumes. DO NOT BREATHE SUCH DUST OR FUMES.

HOT WATER

EXTREME HEAT occurs in the electron collector portion of microwave tubes during operation. Water channels used for cooling also reach high temperatures (as high as boiling, 100°C or above), and the hot water is under pressure (typically as high as 100 psi). A rupture of the water channel or other contact with hot portions of this tube could scald or burn. Take precautions to prevent and avoid such rupture or contact.

HOT SURFACES

The electron collector portion of microwave tubes is often air-cooled or conduction-cooled. The air-cooled external surface normally operates at a high temperature (typically 200° to 300°C). Other portions of the tube may also reach high temperatures, especially the cathode insulator and the cathode/heater surfaces. All hot surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to prevent and avoid any bodily contact with these surfaces both during and for a reasonable cool-down period after tube operation.

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PALO ALTO MICROWAVE TUBE DIVISION • 611 Hansen Way • Palo Alto, California 94303

APPENDIX A

TWT RF AMPLIFIER DATA

MODEL LR620-10 SERIAL NO. 4421/014

TIME DELAY 60.0 SECONDS

NOISE POWER OUT -10.0 dbm

FREQUENCY	SAT POWER OUTPUT dbm	SMALL SIGNAL GAIN db
1.0	45.0	35.4
1.1	45.5	36.3
1.2	45.5	39.1
1.3	45.3	39.0
1.4	45.0	38.5
1.5	44.8	38.8
1.6	44.0	38.5
1.7	43.5	36.5
1.8	42.8	36.1
1.9	42.0	35.5
2.0	41.0	33.5

LINE REGULATION 103-121VRMS ✓ (✓)

DATE 6.26-74 TESTED BY Sam Mayfield

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO. 09062	74A0574
	SCALE	SHEET	REV

APPENDIX A

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2.0	41.0	33.5

LINE REGULATION 103-121VRMS ✓ (✓)

DATE 6.26-74 TESTED BY Sam Mayfield

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO. 09062	74A0574
	SCALE	SHEET	REV

APPENDIX A

TWT RF AMPLIFIER DATA

MODEL LR620-10 SERIAL NO. 4471/014

TIME DELAY 60.0 SECONDS

NOISE POWER OUT -10.0 dbm

FREQUENCY	SAT POWER OUTPUT dbm	SMALL SIGNAL GAIN db
1.0	45.0	35.4
1.1	45.5	36.3
1.2	45.5	39.1
1.3	45.3	39.0
1.4	45.0	38.5
1.5	44.8	38.8
1.6	44.0	38.5
1.7	43.5	36.5
1.8	42.8	36.1
1.9	42.0	35.5
2.0	41.0	33.5

LINE REGULATION 103-121VRMS ✓ (✓)

DATE 6.26-74 TESTED BY Sam Mayfield

KELTEC FLORIDA FORT WALTON BEACH, FLORIDA	SIZE A	CODE IDENT NO. 09062	74A0574
	SCALE	SHEET A1 of A1	REV

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